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ABSTRACT

This collection of 20 papers represents the work of 24 authors with a variety of perspectives on the growth of the science, technology and society movement in the United States in the past 10 years. These essays are seen as a representative sample of the work of the movement. Divided into four sections, Section 1, "General Science, Technology and Society Studies," includes: (1) "The Policy Discourse of STS: STS as an Issue Area and Interaction Network" (Lars Fuglsang); (2) "Public Perception Issues: Agricultural and Environmental Biotechnology" (Charles Hagedorn; Susan Allender-Hagedorn); (3) "Controversies over Evolution and Creationism: Toward a Postmodern Historiography of Science" (Michael Seltzer); (4) "Mathematics: An Important Interface Language for STS" (Glenda R. Haynie; W. James Haynie); (5) "Women and Genes: Finding the Right Fit" (Deborah Blizzard); and (6) "Community or Commodity? Reconsidering the Environmental Movements in Taiwan" (Shih-Jung Hsu; John Byrne). Section 2, "Science, Technology and Society Collegiate Programs," contains: (1) "Teaching Information Self-sufficiency in the Academic Disciplines: A Three-tiered Approach" (Deborah S. Grealy; Lorraine Evans); (2) "Integrating Ethics into Undergraduate Research: The NSF Research Experience for Undergraduates Program" (R. Eugene Mellican); (3) "A Multimedia Approach to Computer Ethics" (Frances K. Bailie); (4) "Development of an Undergraduate Environmental Curriculum in Bangladesh" (Cub Kahn); (5) "What We Learn from Role Playing in an STS Activity" (Cheng-Hsia Wang); (6) "An STS Activity--Ozone Depletion" (Cheng-Hsia Wang); (7) "The Chinese Reforms and the Rationalization of Environmental Dispute Resolution" (Abigail R. Jahiel); and (8) Physics: Concepts and Connections" (Art Hobson). Section 3, "Science, Technology and Society in K-12 Education," includes: (1) "Available, Ready To Explore" (Bernice Hauser); (2) "High School Students' and Teachers' STS Outlook Profiles. Are There Gender Differences?" (Uri Zoller; David Ben-Chaim); and (3) "How a City Works: A Professional Development Institute for Teachers" (Debra Azzel and others). Section 4, "Technologies, Boundaries, and Realities: Dancing on the Borders of Human and Machine," contains: (1) "A Deconstructive Demi-dance" (Suzanne K. Damarin); (2) "Women Computer Scientists" (Linda Condron); (3) "The Paradox of Technology for Persons with Disabilities" (Jan Johnson); and (4) "Yellow Roses: The Case against the Name 'Virtual Reality'" (C. Allen Shaffer). (EH)

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PROCEEDINGS OF THE TENTH NATIONAL TECHNOLOGICAL LITERACY CONFERENCE

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Arlington, Virginia
March 2-5, 1995

Edited by
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TENTH NATIONAL TECHNOLOGICAL LITERACY CONFERENCE PROGRAM

INTRODUCTION

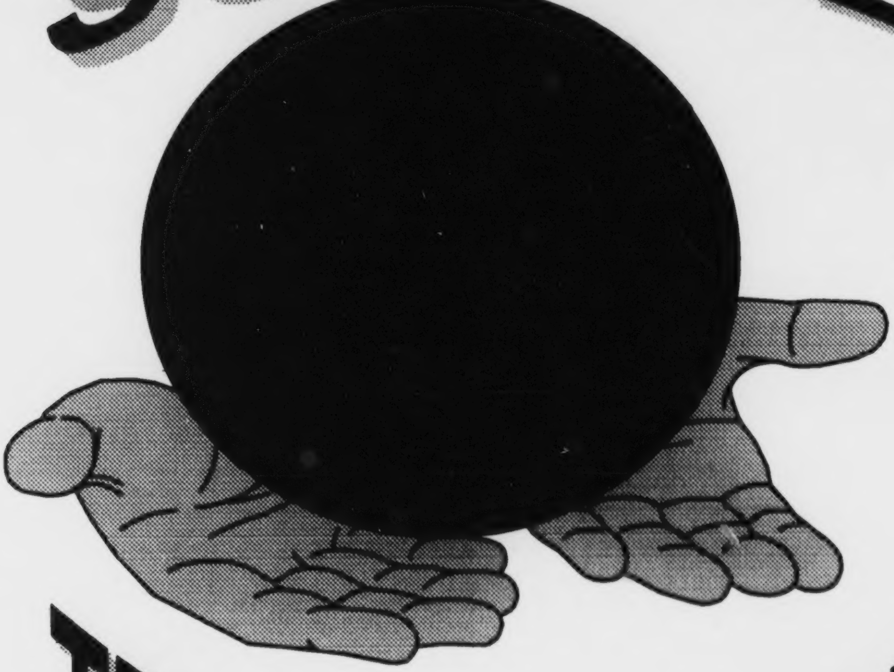
This proceedings volume represents a major milestone in the evolution of the science, technology and society movement in the United States. When the first Technological Literacy Conference convened in Baltimore in 1981, little did its planners realize the path it would take and the subsequent growth in the worldwide science, technology and society movement. This tenth National Technological Literacy Conference is testimony to the continuing interest in STS studies and programs among collegiate, K-12, public interest, religious, and other types of institutions and organizations. The past decade has witnessed the incorporation of the National Association for Science, Technology and Society (NASTS), steady involvement of a number of organizations as annual sponsors of this venue, the proliferation of a host of journals, newsletters, books, and other publications in the fields of STS, and a continuing and healthy debate about the scope and purpose of the STS movement.

The 20 papers in this collection represent the work of 24 authors with a variety of perspectives. They provide some flavor of the varied sessions at the tenth anniversary conference and the growing maturity of the movement. The Conference program gives a fuller sense of the range and interests represented by the STS movement.

Conference proceedings from the past nine conferences are all accessible within the ERIC database. NASTS would like to take this opportunity to acknowledge the fine assistance in electronic publishing of our proceedings volumes that we have received from Dr. John Patrick and the staff of the ERIC Clearinghouse for Social Studies/Social Science Education at Indiana University, Bloomington. It is with delight that we present these papers to a larger audience and invite you to further conversations at future Technological Literacy Conferences.

Dennis & Kim Cheek
Editors

GENERAL SCIENCE, TECHNOLOGY AND SOCIETY STUDIES



THE POLICY DISCOURSE OF STS:
STS AS AN ISSUE AREA AND INTERACTION NETWORK

Paper prepared for the *National STS Meeting and Technology Literacy Conference*, Arlington, VA, USA, March 2-5, 1995

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This paper seeks – at the theoretical level – to explain Science and Technology Studies (STS) as an "issue-area" within international policy-making. The paper attempts to show how the issues of STS are promoted in relation to the state, the citizens and the market. It applies an open organisational approach in order to explain this. This implies that the social and political institutions of science and technology are defined as interaction-networks that are open to strategic discourses and scholarly campaigns at different levels. Furthermore, recent networks are seen as constituted by new concerned social-professional groups rather than broad social movements or interest groups. The paper analyses some of the strong and weak points of STS campaign strategies at the institutional level, and discusses some options for strengthening the policy discourse of STS. It argues that a "follow the actor approach" and modified methodological individualism are appropriate methods to understand and study STS as an issue area. The usefulness of such an approach is to identify some of the specific options, barriers and mechanisms for integrating the institutional concerns and collective choices (STS-issues) with technological change and innovation.

The paper is divided into three sections. The first section explains some tensions between competing discourses of STS. The second section explores – at the theoretical level – how STS in the form of technology assessment (TA) presents itself in different ways in relation to the market, the state and civil society. The third section applies industrial organisation theory to discuss some further options and barriers for TA to become constituted as a policy-discourse.

1. Tensions and discourses of STS

1.1. STS as an institution

It is clear from many studies that there exists a wide number of topics and perspectives in Science and Technology Studies (STS) which suggests that STS is a lively but also to some extent a fragmenting academic field (cf. Staudenmaier, 1986; Cutcliffe, 1989; Fuller, 1993; Fuglsang, 1993). Tne tensions and differences within STS are not alone due to disagreements about the scientific method or the disciplinary foundations of STS. They are also rooted in the normative orientations and "political" ideas concerning the application of STS. Hence, it is accepted by many STS scholars that STS and innovation studies have several "tracks" or paradigms (cf. Rip, 1994). Some have for example an academic orientation while others are based on STS as a social movement. The expression of Fuller, that there exists a "high church" and a "low church" of STS is already widely applied in the community (Fuller, 1993).

The attempt to stress the relation between STS and social and political institutions is not merely a research choice in favour of the "low church" (though this may also be true). It fits an important political-economic discussion of the character and role of institutions and networks in society (cf. March & Olsen, 1989; Marsh & Rhodes, 1992). This deliberation could be important for understanding the impact of institutions related to science & technology; STS could be seen as an institutional environment to science and technology.

If this sounds technocratic or out of line with the ideas of STS (as academe or social movement), it is probably because "institution" is not good enough defined. In fact, recent institutional theories have led to several interesting hypotheses concerning the role of social and political institutions that could be applied in relation to STS. This may provide a new perspective on the basic problems and options of STS that avoids the somewhat futile distinction between STS as social science or movement. Below, I have listed what I think are three important recent institutional assumptions:

1. Social and political institutions (e.g., those related to science and technology) are not to be seen as mere reflections of economic needs, political struggles, or as autonomous. They are seen in a more dynamic way as relatively independent institutions that play a formative and educative role.

2. Institutional frameworks are to be defined, not as closed, bureaucratic hierarchies, but as open interaction-networks centred around specific policy problems (such as technological change) or other types of social, economic or cultural problems. Actors relate to and perceive such problems in different ways, thus becoming part of the interaction-network for different reasons.

3. Institutions – defined as interaction-networks – are not to be seen as homogenous, differentiated and functional units (like Weber's bureaucracy), but as heterogeneous and fragmented structures that involve opportunistic action and asymmetric information. In that sense, one cannot study institutions alone by investigating formal structures, rules and purposes. The rules and structures are changing and motives and purposes for participating are contradictory. The focus would have to be on the different actors, their preconditions, objectives, influence on the rules, etc. Thus, one appropriate way to study institutions would be a "follow the actor" approach.

These assumptions could mean that STS is seen as an institution that (as science or social movement) plays a formative role in relation to science and technology. STS would thus be part of an institutional framework that embeds science and technology. Still, there would be different institutional opportunities for STS in different places, and actors can have different motivations for participating in STS as an interaction-network. Along these lines, an attempt to analyse and reconstruct STS networks would also have much wider implications for understanding the political organisation around technology in different political-economic systems – it would not be such a narrow discussion of minor academic disagreements.

1.2. The institutional concerns of STS

For the purpose of this paper, it is not possible to go into detail with the particular organisations of STS in selected areas or countries. The intention is to specify some of the competing ways STS at the level of discourse presents itself as an issue area or institution in relation to society and policy. Below, I want, tentatively to outline five discussions within STS. Next – as a case of STS – I discuss three discourses of *technology assessment* (TA) in relation to the state, civil society and the market.

The five discussions I want to go through briefly here are: 1) Discussions around the role of scholarly work. 2) Discussions concerning the notion of institutions. 3) Discussions about method of study and method of practice. 4) Discussions between "modernists" and "post-modernists." And 5) discussions between actor-oriented and structural approaches.

1) The role of scholarly work. Clearly there are different ideas within STS about the role of scholarly work in relation to social and political institutions. The discussions here concern whether the work of the scholar can be seen as immediately useful for policy or not. In other words, is it possible to argue that the work of STS scholars in some way is conclusive and should be applied in a specific way, e.g., in the form of policy recommendations or technology assessment (TA). If not, what then is the relevance of the approach?

The idea that STS analysis in some way should be conclusive and immediately applicable is quite central in different branches of STS, for example in innovation studies or economics of innovation. Here, there is an ongoing discussion about whether STS could be used to predict some aspects of technological change, just like conventional equilibrium approaches in economic theory, or whether STS should lead to strategic policy recommendations to be followed by politicians. For example, the idea that technical change follows a trajectory and is path-dependent, or that firms are idiosyncratic with a narrow agenda, would lead to "realistic" predictions of actors' behaviour that could be relevant for policy-analysis (analysis of strong and weak points). Other studies seek to explore the rationale of innovation studies for policy, given innovation is not predictable. The analysis is centred around notions of market failure, uncertainty, strategy, structural aspects of the economy, political economy, etc. Most of these studies are holistic-system-oriented and focus on the role of the technological infrastructure using concepts like the national system of innovation, clusters of innovation, development blocks, etc.

In policy oriented studies, attempts have also been made to apply STS approaches in an effort, for example, to analyse how the institutions of science and technology can be improved. Different forms of input-output analysis have been applied, such as patent or citation studies, to measure and evaluate the performance of a given science or technology institution – and indicate to what extent it should be improved or re-organised. Certain policy studies recommend that science and technology should be "autonomous," i.e., protected from societal forces in order not to be prostituted or frustrated. Others point out the need for a closer connection between science and industry. Furthermore, political scientists are interested in the power aspects of science and technology, the role of social movements, and the application of various democratic models.

Other approaches to STS have politically attempted to interfere with science and technology on the side of specific interests, such as the Scandinavian projects in "working life science." Here, STS scholars worked together with graphic workers in newspaper type-setting in order to provide better conditions for technical changes at the firm level , taking workers' skills into consideration. The basic idea was that technical changes often involve a clash of interests, and that workers' interests often are ruled out in the name of technical efficiency and economic benefits. However, this may in the long run be a counter productive strategy since the skills and ideas of employees are important for the innovative capacity of an organisation.

Nevertheless, just as it may be claimed that inputs from public sector R&D to industry are most often indirect and informal, an alternative – more "academic" – discourse would assert that the role of STS in relation to policy and economy is at best indirect and informal. Along these lines, STS analysis is not conclusive but supportive of certain efforts in technological development and innovation. STS can provide inputs to policy formulation, not lead to specific implementations. It can perhaps study and criticise the implementation process, though not interfering directly with it (of course it can do this in specific contexts, but not with much efficiency or momentum). Furthermore, STS can influence the education of scientists and technologists as well as the attitudes of the general population. It can also help build up an institutional environment for the assessment of science and technology, without actually intervening directly with science and technology.

Seen in that way, the scholarly work of STS is not immediately useful. It provides one form of organised knowledge with certain questions and theoretical perspectives that may be helpful for the formulation of certain types of problems within a wider institutional setting. STS as an institution, social movement or mosaic of perspectives can thus be said to have some relative independence vis-à-vis other institutions and society in general.

2) The notion of institutions. Another normative and theoretical problem concerns the role assigned to political and social institution that embed science and technology. What kind of framework do such institutions provide for society? Are they to be seen as hierarchical, closed institutions that only obey internal rules? Are they open to strategic and political competition and external groups? Are they developing in an organic way together with the environment? These different understandings have quite different implications for the way one looks at the options of STS for influencing science and technology. For example, if institutions are not assumed to be closed, hierarchical organisations or organic units, then the power structures of society are much more diffuse and anarchistic than is normally believed.

This may very well be the state of the art in many areas of modern science and technology. This is particularly true in organisations or countries that emphasise the *diffusion* of certain technologies that are developed elsewhere. What matters in such places is often the practice of engineers and entrepreneurs, and their capacity to combine technology in new ways using experience and trial-and-error methods. But even organisations that pursue a scientific or technological "mission" in order to develop some new radical innovation (like putting a man on the moon) are often fragmented, anarchistic and highly politicised (take the discussion of NASA's role in relation to Challenger's crash). There is evidence that the choices made for science and technology also here are strongly dependent on given resources, experience and clusters of innovation rather than management intentions or political objectives.

Hence, the assumption made by Bernal and others about the potentials of a completely autonomous and independent science (and technology) that is not frustrated or prostituted by societal interests appear to be unrealistic. The influence on science and technology from social and political interests is, however, not necessarily chaotic or completely disorganised. But it may well be that it takes place at a fairly disaggregate level, i.e., in competing networks, around certain activities and experiences, etc.

If one looks into, for example, the democratic influence of science and technology, it is not difficult to come to the conclusion that there are many competing networks, democratic models, and organised initiatives at work at one and the same time. In the Scandinavian countries, where the democratic impact is perhaps stronger than in many other places, one can at least distinguish between five forms of democratic influence: Representative democracy (e.g., parliamentary technology assessment), user democracy (e.g., various social experiments at the work place or in civil, local societies), neo-corporatism (i.e., various initiatives channelled through labour unions), pluralism (a growing number of interest groups seeking to promote their specific interests) and etatism (normative experts working in the context of ethical committees, etc. within the state).

3) Method of study and method of practice. In STS, there are also competing discourses around methodology that give rise to different ideas of STS as an institution and political issue area. One good example of this is the different meanings and paradigms that have crystallised around the notion of "bottom-up" methods. While there probably is a common origin for that notion (most likely a political one), today the meaning of bottom-up is increasingly being converted along the lines of a more scientific and objective method of study, applied for example by social constructivists (the snow ball methods), but also more widely in the social sciences.

As a method of study, the bottom-up approach comes in pairs with a top-down approach which together are believed to make a more complete framework for empirical work. Hence, the top-down approach would start with the "top," i.e., the objective of a specific (scientific / technological) programme, as outlined for example by a company, an organisation or a government, and then study the project – and how it changes – throughout the implementation process, i.e. during the implementation of administrative principles and procedures, the set up of an administrative unit, decision-making by this unit about specific projects related to the programme, final use of funding, evaluation by users and so on (cf. Lundquist, 1987). Often, a project will change quite a lot during these stages because the actors in control are changing and they have different opinions and experiences. As a supplement to this method, the bottom-up approach is therefore offered as a more contextual analysis of the programme and actors involved. This form of evaluation starts in the other end, with the application of the programme, i.e., the users' perception of it, the ideas and role of different relevant actor groups, etc. This approach could include a more value-based analysis. It is argued that most project-evaluations will, and probably should, contain a combination of top-down and bottom-up analysis – just to make the bottom-up approach even more "scientific" and respectable.

Evidently, these methodological considerations have little to do with a more practical and political implementation of the "bottom-up" approach. Here, the scholar would focus on technologies or other projects that emerge from the bottom, based on local initiatives and extensive participation of user groups or technology practitioners. The bottom-up method of practice could take the form of an advisory analysis, seeking to promote certain types of project-building. It could also be a participatory one-party research with the aim to support the views and needs of certain user groups or employees.

4) "Modernism" and "post-modernism." Behind many of the above discussions also lies a conflict between "modernist" and "post-modernist" discourse. It is not the place here to go into much depth concerning that discussion. Briefly, the modernist discourse tends to imply that social and political institutions are rational, differentiated and specialised. Society's institutions as a whole are believed to form a rational unity. The post-modernist discourse, by contrast, claims that there is plural and fragmented relations among different actors, institutions and ideas.

As for the normative role of STS, the modernist approach could imply that the scholar engages in a critical dialogue between institutions and the civil society; but the scholar would be in favour of technological progress as a relatively autonomous development process. The post-modernist view would suggest, rather, that the scholar could analyse competing scenarios and styles. Hence, in regard to technological change, the modernist would work for further expansion of science and technology and more optimal institutional conditions and control (or perhaps he would have a rather pessimistic evaluation of the prospects of this development while also exploring mechanisms of popular control). The post-modernist view would underpin different forms of science and technology and the value-input to them.

5) Actor-oriented and structural approaches. The taxonomy of a structural and an actor oriented analysis also are part of a vocabulary that brings to attention the different roles of STS in relation to policy. Structural analysis often is supposed to focus on the basic political-economic structures of society, the broader trends, or the long waves. These are most often believed to determine society's development, for example, technological developments. The structural determinist approach is "non-intentional," because actors are believed to adapt to the structural pre-conditions of society and society's institutions in a relatively unproblematic way.

By contrast, in actor oriented analysis, the intentions, decisions and strategies of actors matter more. The starting point here is the actor's perception and interpretation of given problems, his or her role within networks and influence upon the rules of the game. In this case, the relation between individuals and socio-economic structures is seen as more problematic and strategic, though some theories assume perfect information and rational choice of the actors.

As for the normative implications of these discourses, they are of course manifold and largely dependent on the single scholar's position and ideas. However, structural, macro-level analyses most often lead to rather determinist views on social and technological change where the major task of the scholar would be to uncover the "laws" and the nature of this development. Corporate strategy and government policy would be seen as reflections of, and strongly "path-dependent," on wider social structures.

Actor oriented approaches often include a notion of strategy, be it within a game theoretical framework, theory of strategic management and planning or strategic analysis. Corporate strategy, government policy and even the single actor is believed to *make a difference*. The scholar may be part of strategy-formulation deliberations of, for example, government technology policy agencies.

One simplified – partly alternative – way to summarise the relation between different STS discourses is the distinction below between the narrow and the extended view on technology and social institutions.

	Narrow understanding	**Extended understanding**
State	Rational, differentiated	Politicised, value-based
Civil society	Differentiated, homogeneous	Heterogeneous, fragmented
Market relation based on	Price / quantity	Interaction
Division of labour	Functional	Social
State-market linkages	General, structurally determined	Specific
Innovation	Technical	Organisational
Role of scholar	Improve institutions and critical dialogue	Explore value base / meaning assigned to institutions
Method of scholar	Observation	Comprehensive participatory observation

Figure 1: The narrow and the extended understanding of STS

Hence, in the narrow understanding, STS would see itself in a rather specific role in relation to policy. STS could attempt to point out inefficiencies, such as weak points in institutions of science and technology, for example by means of patent and citations studies, or through different forms of input-output analysis. The focus would mostly be on structural-formal (hierarchical) aspects of the economy.

In the extended model, the research strategy and research questions would be somewhat broader. More attention would be devoted to the political-economic preconditions of the actors, their different competing strategies, the fragmentation of the social context in which they operate, interaction networks, informal structures, information problems, problems and options of co-operation, etc. The research strategy would not be neutral observation alone, but also a "follow the actor" strategy. This would also allow for participation in policy-formulation and exchange of information.

A related and partly overlapping way to illustrate some of the differences between STS discourses is through a distinction between a rational choice discourse and an evolutionary discourse.

Rational choice discourse of technical change	**Evolutionary discourse of technical change**
Science & technology push	Need pull
Radical innovations	Incremental innovations

Development of new technology	Diffusion of technology
Process innovation	Product development
R&D intensive	Engineer based
Knowing	Doing
Theory	Practice
Rational prediction	Evolutionary, experience-based

Figure 2: STS as rational choice or evolutionary discourse

Thus, in the rational choice model, the task of STS would be to point out certain market and government failures and estimate how they could be resolved. The objective could be the development of new technology based on the establishment of new science institutions, and an economic framework for measuring the success of that development would be quantity and price competition and thus ultimately the possibility of economics of scale (i.e., process innovation).

The evolutionary model would start in the other end, with the experience, routines and resources of the actors. STS would analyse strong and weak points of different technologies in relation to certain actor groups, their role and strategy in industry networks, etc. In this way, STS analysis could stimulate the formation of policy networks; the analytical work would be a basis of exchange of information. STS could also identify strategies of best practice or be supportive of certain selected resources. STS would thus become more politicised and value based.

In practice, STS pursues of course different sets of combination of the mentioned discourses or approaches. However, it would be interesting to see how the conditions for STS with respect to these strategies are different in different countries or in relation to different areas of interaction, such as the state, the market and civil society. The following section will focus on the latter.

2. TA as an issue-area and sub-field of STS

In order to understand in more detail the different barriers and opportunities of STS for constituting itself as an issue-area in relation to policy, it may be relevant to look at some of the sub-fields of STS and the conditions under which they make or should make their discoursive choices. Here, I will focus on one such sub-field, namely technology assessment. Below, three basic discourses of technology assessment (TA) are tentatively discussed and compared. In section three, I apply certain ideas of industrial organisation theory in order to further develop some problems and options of TA.

The three discourses of TA that I want to discuss I call parliamentary TA, citizen-oriented TA and strategic TA. Indeed, these are not the only existing forms of TA, and they hardly exist in the stylised form discussed below. Recently, new theoretical perspectives have been widely discussed (cf. Baark, 1992; Smits, 1990: Leyton & Smits, 1993; Cronberg, 1992). The issues and perspectives outlined below should, however, be seen as three trends of TA particularly during the 1970s and 1980s. To some extent, they have outplayed other initiatives of TA.

2.1. Parliamentary TA

One of the most important contributions of TA is the effort to create an institutional discourse for providing better information for policy-decisions about technology, especially within parliamentary assemblies. The Office of Technology Assessment (OTA) and the British Parliamentary Office of Science and Technology (POST) as well as the Danish Board of Technology work under the auspices of parliamentary assemblies (or the congress), and their main task is to provide relevant information for decision-makers. There are undoubtedly differences in style and orientation of the different parliamentary discourses (cf. Vig, 1991). For example, one difference between European TA and TA in the United States is that in the United States the congress has wide legislative independence, which is not true for the parliaments in Europe, where governments often have the legislative power.

Parliamentary TA includes different techniques, such as data-base search, interviews, cost-benefit analysis, scenarios, macro-economic analysis, and also to a certain extent more qualitative methods, such as Delphi, social mapping (identification of relevant groups), workshops, etc. By and large, the main purpose of parliamentary TA is to provide a discourse of so-called "objective" data and information for decision-makers and public debate. Most often, parliamentary TA focuses on specific technologies and the consequence of technology in society.

Parliamentary TA is, indeed, important and has significant consequences for the quality of public debate as well. Without the many important reports and papers from OTA, POST or the Board of Technology, it would be much more difficult to influence public attitudes to technology. However, this influence on attitude is no guarantee for success at the policy level. In fact, there is evidence that parliamentary TA has no or very little influence on policy decisions. Furthermore, the public debates on technology are, after all, quite limited.

There are several explanations of the relative failure of TA to influence policy-making at this level. One is that this TA discourse has not been good enough to define its role in relation to policy-making. For example, the Board of Technology of Denmark has most of the time had a very low status in the Danish parliament. A related problem may be that the policy-context of TA is difficult to come to grips with since the discourse of "technology" is many-faceted compared with other policy-problems, such as unemployment. A third reason may be that parliaments have not been willing to deal sufficiently with the topics because they are leftist and not progressive enough.

One major *institutionalist* explanation – that summarises these different reasons – can be given with reference to the motivation of individuals. The idea is that policy-discourses must seem beneficial enough for individual actors to push the issues on policy-agendas. Hence, the problem of TA may very well be that it appears idealistic. Nobody really seems to benefit from it at the individual level in the policy process. In brief, policy actors cannot really use TA in their individual policy career as an instrument either of public choices or personal utility. In other words, there are no votes in it, no important information that can be used in relation to other issue-areas or actors, no political prestige, no significant rules that express important public choices, no "resources," such as manpower or money, and no sanction-mechanisms related to it. Along these lines, the problem seems to be that TA is not defined in relation to important public concerns or around important new policy institutions with sufficient pressure.

The contention of this paper is that this explanation is crucial and would be important for any policy discourse or issue area. Hence, policy-actors must behave strategically; they must engage in campaigns that give rise to real political pressure. In order to do so, they should probably interact with organisations that share with them the basic understanding of the problem. By contrast, it may be counter productive to seek influence in institutions where no-one takes interest in TA. At this point, it would be important, however, not to adopt a narrow understanding of institutions or the state / parliament as established, closed discourses that cannot be influenced at any level from the "outside." It would be more operational to assert that institutions are affected by plural strategies, not one core strategy, as long as these strategies are sufficiently efficient. Hence, perhaps TA should be supportive in a variety of settings where some pressure can be established, for example in relation to different user groups (e.g., in schools), consumer groups, environmental groups, firms, etc.

2.2. Citizen-oriented TA

Citizen-oriented TA is a discourse about informing the public rather than the parliament. Just like parliamentary TA, it takes many forms and overlaps in some instances with parliamentary TA.

The basic idea is that TA provides a mechanism that helps citizens to express their attitudes and raise their voices in relation to technological changes – while the present paper suggests that some emphasis on rules, strategy and political pressure may also be important. Voice can be expressed through more or less institutionalised forms of public protest, public debates, social experiments or certain forms of organised debate, Delphi methods etc. Seen in this perspective, TA is not merely a narrow method or organisation, but part of a wider social discourse that values voice.

Public protest is perhaps the most significant and important form of citizen-oriented TA. Hence, public protest over nuclear energy, gene engineering, pollution, automobiles, etc. have led to a number of regulations and policy changes that have had an impact on technological changes, such as increased security in nuclear energy, experiments with alternative forms of energy, tax reductions for unleaded gasoline, etc. Essentially, public protest can be said to have nothing directly to do with TA method. It is often spontaneous. It could be related to a specific technology (typically the introduction of new technology in work) or organised around user organisations or individual leaders (environmental organisations or leaders like Jeremy Rifkin or Ralph Nader). Most often, public protest leads to important discussions about common pool resources where the problem is to establish rules against over-exploitation of nature.

Public debate can be defined as a softer form of public protest that often is stimulated through external forces, such as public protest or governmental offices that intend to initiate or organise the debate. There is no doubt that the media also play an important role in public debates. Public debates may also be organised in relation to certain organisations where user groups have strong interests in and benefit from seeking influence on policy, such as schools or hospitals. These debates sometimes contain a wider policy problem, such as treatment in hospitals or learning methods in schools. They can also be more narrowly linked to a specific technology, such as birth control technology.

Social experiments are somewhat more constructive and future-oriented experiments with technology that focus on the implementation and consequences of new technology, for example at the workplace, or the shaping of technology at work or in local communities. Such experiments have been supported in Scandinavia by labour unions and local communities, and have influenced the direction and form that TA has taken. One principal purpose of these experiments is to support the views and ideas of employees or community members in the implementation of new technology so that the attitudes, ideas and needs of these social groups are better explained.

Certain forms of organised debate include, for example, Delphi methods, where expert opinion on new technology is scrutinised and synthesised through different phases of qualitative interviewing. This method is supposed to bring qualified information for public discourse over technical development. A more elaborate form of debate which involves lay opinion as well as expert opinion is the consensus conference, which has developed into a kind of Danish speciality of TA. The consensus conference is a trial with a" jury" of lay people questioning an expert panel about a specific technology. The jury's verdict is a consensus report that can be used by the relevant decision-making body in the parliament.

The problems and barriers of this discourse of TA to constitute an issue-area for policy are somewhat different from parliamentary TA. The campaign strategies of this discourse are somewhat stronger (cf. the role of public protest or the consensus conference), though the audience (the general citizen) is perhaps not always able to influence the policy-agenda.

It could be important to connect citizen-oriented campaign strategies to somewhat wider audiences and policy-problems and develop more explicit rules. Hence, TA issues could for example be better integrated with binding professional norms, and thus linked to professional societies. It may also be much better integrated at the firm level, not merely as a critical discourse, but also as an attempt to develop procedures for such phenomena as innovation activities and quality development. At this level, there are options to relate to certain strategies of capability development and quality control. In these different contexts, it is important that TA not merely is seen as a critical force, but also as a more dynamic strategic force that has a utility function for different sets of actors.

2.3 Strategic, market-oriented TA

Strategic TA is an attempt to link TA with industrial and technology policy discourses. The arguments for this approach are present in a number of papers concerned with TA and industrial change (cf. Smits, 1993). The approach is inspired by analysis of recent industrial developments.

The line of reasoning is that strategic, supply-side policies are becoming more important and should be coupled better with demand side policies. Hence, markets have become more open, economic actors more export-oriented, and quality is increasingly combined with price as a competitive factor. In this changing climate of innovation and technological change, it becomes more difficult for economic actors to control industry from the top. Sub-contractors may play a more important role than is normally believed. Uncertainties and appropriability problems in connection with R&D investments are growing. It also becomes more difficult to regulate the economy on the demand-side because of the more open markets.

This leads to a shift in government policy from demand side to supply side policies (cf. Jessop, 1993), from reactive to pro-active policies (cf. Fuglsang & Pedersen, 1994), and from general to strategic policies. However, in this permanently innovative economy there is a growing need for interaction, for example between users and producers, because innovation cannot be based on anonymous market relations.

Strategic TA may play a role here in seeking to re-introduce the demand side in policy-making. For one thing, TA may take up discussions of technology and social development in a way that is functional to industrial policy and industrial development. TA may also stimulate and promote technological development in certain sectors and areas and prevent it in others. TA could also support and motivate end-users to intervene with technological innovation (Andersen & Lundvall, 1988; Leyton & Smits 1993) or generate new forms of services, including new types of jobs in relation to technological development (cf. OECD, 1988).

Strategic TA sounds like *the* solution for TA to establish itself as an issue-area for policy. However, the strategic discourse of TA is in fact vague in regard to more specific options for intervention and pressure. Furthermore, it may well be that TA here seeks to be part of a policy process that in fact runs its own campaign, since, for example, industry clearly wants to interact more with users in order to maintain its competitive advantage.

In order to promote this view further more emphasis could be placed on the mechanism of social choice, i.e., how industry directly or indirectly can be forced to chose strategies that correspond with user strategies. More emphasis could also be placed on the uncertainty of strategic policy in different situations, where actors are difficult to mobilise and many barriers exist for user-friendly innovation and sustainable development. What strategic policies or other mechanisms can be deployed in relation to such economies? In other words, the weak point is again the pressure mechanism and campaign strategy.

2.4. A brief comparison of parliamentary, citizen-oriented and strategic TA

The three orientations of TA discussed so far can, as indicated, be seen as discourses that refer to different subjects, objects, and concepts of TA. These different discourses are partly competing with one another, and they present the problem of TA – to become an issue area for policy – differently.

Hence, the subjects represented in the discourse of parliamentary TA are actors concerned with the national policy-making process. The discourse deals with objects such as legislation, objective information and power (the state), and applies concepts that associate the TA discourse with notions of welfare and sustainable development.

The subjects of the citizen-oriented TA discourse are the "average citizens" who are supposed to operate through some form of voice and debate. These agents are concerned with environmental and civil society problems in relation to work place and the local community. The concepts applied in this discourse emphasise democratic planning methods.

The subjects of the strategic TA discourse are concerned user groups within industry or in relation to industry (user groups, social movements). The actors referred to respond to user-needs and deal with problems of industry and the market, but the vocabulary used emphasise constructive planning methods that take into account the various problems of business planning and the market.

	Parliamentary TA	Citizen -oriented TA	Strategic TA
Subjects	National policy-makers.	Average citizens, researchers.	Business managers, concerned user groups.
Objects	Legislation, power. The State.	Work environment, local community. Civil society.	Industry. The market.
Concepts	Welfare economics, Sustainable development.	Democratic planning.	Constructive planning and business administration.
Campaign	Information.	Voice.	User-needs.

Figure 3: A comparison of TA discourses

Judging from this brief analysis (and my further thinking about this), it appears to be fairly easy to point out the subjects, objects and concepts of these discourses, but much harder to identify the precise campaign strategy and pressure mechanism for gaining influence and power as well as the motivation of the subjects (politicians, citizens, concerned users / industrialists) to actually participate in interaction-networks that support this discourse.

It is not wrong to suggest that TA will have to sophisticate its discourse concerning these matters if it wants to present itself as a serious challenge to existing policy discourses and continue to interest and enrol actors. Furthermore, to my mind, there has been a tendency for TA to move in the direction of a "high church" strategy (a more respectable, academic discourse), while perhaps neglecting the need for wider social and political campaigns and discussions of the relevance of TA in an institutional and social context.

3. Social choice and TA

In order to see how TA could strengthen its campaign at the strategic level – as an issue area for policy that interests and motivates actors – it seems relevant at the theoretical level to understand some problems concerning "social choice" in relation to TA.

Below I want briefly to indicate how a more powerful discourse could be constructed, elaborating tentatively four thematic issues of industrial organisation theory that I find relevant for this purpose. Industrial organisation theory is relevant in the line of reasoning that focus on the rules, strategies and benefits that lead actors to specific action.

3.1. Two subsets of industrial organisation theory: structures and actors

The theory of industrial organisation consists, in fact, of a number of competing theories some of which are more mathematical than others, some more "game-theoretical," and some more soft and broad (for recent presentations cf. Tirole, 1989; Symposium, 1991). Furthermore, some periods of industrial organisation theory appear to be more theoretical than others, where more empirical, case-study-oriented or intuitive analysis dominate.

One important distinction within industrial organisation theory is between industry-structure oriented approaches and actor-oriented approaches (i.e., methodological individualism).

The structural approach stresses the broader socio-economic structures and their impact on actors. This approach goes back to classical political economy. For example, classical economic analysis implies that the structure of division of labour determines the behaviour and role of actors. Marxian analysis argues more or less that productive forces play such a determinant role. Weber's theory of bureaucracy generally suggests that differentiating bureaucratic structures define actors' role. Little attention is devoted to the possible conflictual relations between the actor and the structure. Another structural approach is classical institutional theory and some aspects of new institutional theory, especially organisational sociology (cf. Powell & DiMaggio, 1992). Here, the focus is typically on routines within institutions or organisational cultures and their impact on individuals.

In industrial organisation theory, the structural approach concerns the structure of industrial sectors or the fundamental institutions and traditions of division of labour among firms. The industrial structure approach may also look at long waves of economic development and systems of innovation. Most of the modern industrial structure approaches are modified structural approaches, since the relation between actors and structures is not described as unproblematic. For example, theories of long waves of technical change devote attention to the mismatch between economic structures and social and political institutions (cf. Freeman & Perez, 1988). Theories of industry structure in the more narrow geographical sense, for example theories of development blocks (cf. Dahmén, 1988), linkages, agglomerations (cf. Storper & Walker, 1989), flexible specialisation (cf. Sabel, 1989), or Porter-inspired theories and theories of national systems of innovation (cf. Lundvall, 1988), often underline different problems of strategy, competition and rivalry and the role of government policy, trust, free rider problems, etc.

Actor-oriented approaches and methodological individualism. The emphasis here is on the individual actor, the relation between actors, and the different pre-conditions of action. Methodological individualism contains a spectrum of analyses from rational choice models to more modified normative models. In the comprehensive rational model, actors are supposed to have perfect information and act rational in accordance with their interests. Other models suggest that actors may intend to act rational while in reality there are a number of limitations on their ability to do so, such as imperfect information, opportunism, or normative problems. More extreme models deal with incremental or even anarchistic models of decision-making.

3.2. Some relevant themes of industrial organisation theory

In this following section, the paper will elaborate the actor oriented approach in a modified form, as a possible input for strategic TA discourses. It is assumed that actors have bounded rationality, imperfect information, and that their preferences are affected by interaction with other actors in interaction-networks. I shall briefly and in a tentative form, discuss four notions of industrial organisation theory that appear relevant for understanding a potential strategic campaign of TA stressing social choice and welfare problems. These concepts are: asymmetric information, incomplete markets, non-price-competition and network economy.

Asymmetric information. The discourse of asymmetric information deals with information problems in a relation between two or more actors. Asymmetric information originally refers to a relationship between two agents where one has more information than the other, for example in judging the quality and price of a given product. The example referred to is often a second hand car or a "lemon" in American slang (cf. Akerlof, 1970). For instance, the person that sells the car usually knows better than the customer how it works. There are numerous mechanisms to avoid the advantage and disadvantage of asymmetric information, such as warranty, insurance, goodwill, etc.

Problems of asymmetric information may stimulate actors to choose sub-optimal solutions from a welfare economic point of view. Hence, asymmetric information about R&D may lead to over-investments if actors are not aware of competitors' investment patterns and invest in the same R&D effort. Asymmetric information may also motivate actors to enter into networks in order to achieve a more trustful situation with better information among actors.

Asymmetric information is an important concern also in relation to problems of technical change from a somewhat broader socio-economic perspective. How can actors be sure that the implementation of certain technologies will lead to employment, growth, less pollution, better working conditions, or the opposite? How can we trust a company, engineer or policy-maker that wants to introduce new technology, to build a nuclear plant, a bridge or new high speed train, supposedly for the benefit of the population? There is evidence that this is difficult to calculate in regard to "Pareto-efficiency" or to judge to what extent projects reflect the preferences of citizens. In the end, these initiatives are a result of strategic action.

From the citizens' point of view, the mechanism that is important from the point of view of making a social (collective) choice together with the promoter of a technology may be to have a warranty that ensures that a given project fulfils the promised purpose. The citizens will have to be able to threaten the promoter in a way that forces him or her to act in a certain way. Indeed, in normal negotiations about projects, there are a number of opportunities to put forward such credible threats, for example threats about strikes, or consumers' and society's boycott of products. Environmental damage can also be an object of strategic campaign, such as threats about fines, taxes, etc..

What are the implications for TA? The problem-context is not the technology itself but a promise or vision in relation to certain technological changes. Hence, what from this perspective appears to be important is the legal and political context where these promises are made, which is – in the case of technical change and innovation – usually within the framework of certain projects. The framework and rules of the projects, the procedure in connection with call for tenders, standards and rules concerning contracts, consumers' strategy, etc. here become central units of analysis. TA may also be assigned power to sanction projects if they – according to certain standards – are not judged sufficiently environmentally sound. TA would thus form a "technology court" – which is not without precedence in such areas as water protection for example.

Incomplete markets. That markets are not complete, but incomplete is also an idea stemming from industrial organisation theory. Hence, many economic transactions do not take place through anonymous market relations, but within organisations where people know each other. Sometimes, these relations are based in barter and do not involve money. The classical problem that illustrates this is the following: If markets, as assumed by economic theory, were complete why would there be firms? As is well know, Coase and later Williamson attempted to solve this problem with reference to transactions costs (cf. Coase, 1937; Williamson, 1972).

Incomplete markets are not solely characterised by high transaction costs and the emergence of firms. There are many other examples of incomplete markets, i.e., situations where markets do not take care of the transactions. For example, many economic transactions with goods are organised through the family and various forms of social relation. This is not just true for markets that are extremely incomplete such as the bazaar markets in Eastern and Central Europe or developing countries. In Western countries also, social bonds and personal contacts play an important role and are often more important than pure market-relations. Furthermore, the way industry is organised in certain industrial districts often rely on various forms of social contract. (This is true, for example, in a community such as the Herning area in Denmark, where companies encourage employees to establish their own company by sub-contracting with them (cf. Illeris, 1992)). Social bonds also work the other way round as restrictions to growth. Hence, in all countries there are numerous examples of firms that for social and cultural reasons are not interested in growth (profit maximation), for example because the owner may risk to lose control over the company to managers.

In the field of R&D investment and technological change, social relations may be quite important. Social and informal relations play an important role as an instrument to create strategic relations among actors that can secure an appropriate division of labour and mobilisation of venture capital, as well as an instrument of secrecy and competitive advantage. There is evidence that informal decisions about regulation standards in relation to technological change (rather than arm's length regulation) and networks of different kinds are important for certain technological breakthroughs and the consolidation of technological trajectories.

Social relations and networks of different kinds are thus important for the ability of actors to benefit from technological and industrial change. This implies, among many things, that the chances of certain technological breakthroughs are dependent on rather impenetrable activity and negotiation.

The general consumer here has an interest in TA as an instrument to open the game. For one thing, because of these often closed industrial organisations, consumers have little influence on the rules of the game and difficulties in communicating their ideas and preferences. Many options and decisions remain obscure. Moreover, social relations constitute entry barriers for newcomers that are not members of important social groups. For them it becomes very difficult to enter the market. TA could here strengthen its role by seeking to expose some of these imbalances and motivate users to intervene with technological changes.

Non-price competition. It turns out that there are many more aspects of competition than price competition, such as reputation, advertising, goodwill, quality control, social bonds, etc. These factors are of increasing importance, especially as a result of recent technological changes and changes of the international economy. Thus, new flexible technologies make it possible to combine quality with price as a competitive factor. The opening of the markets and the internationalisation of the economy with more export orientation goes hand in hand with the crumbling of low price, low quality markets, and more emphasis on quality and reputation.

The more fragmented relations in the economy with more intermediate products between raw material and final products, and more opportunities for sub-contractors at the intermediate stage of production, mean that industries are not so easily controlled by large companies. This leads to new demands for quality control as an instrument of judging the reputation and goodwill of potential sub-contractors.

Generally, these changing circumstances with growing emphasis on non-price competition give new opportunities for TA to become one factor of non-price competition (and TA may also spoil the reputation of certain actors). For the future, it will be important that TA is linked to these different activities and not seen as an innocent institution of its own right.

Industry networks. As mentioned, networks of sub-contractors are undoubtedly gaining much more importance for technological and industrial development than was normal a few years ago. In general this means that the economy is not so much organised through hierarchies but to a larger extent through networks.

What becomes important for TA is to recognise that the new industrial relations may be more open, fragmented and politicised than earlier, and that this development goes hand in hand with a similar development of public administration. Thus, on the one hand, there are many impacts on technical change, while simultaneously the total orientation is becoming more difficult, and political intervention more direct and value-based. No doubt that TA will have to orient itself towards the local level and specific industries in order to have a real impact on strategic choices. But it should also be willing to be "political" and follow the rhythm of policy-making, rather than becoming one academic activity among others.

4. Concluding remarks

This paper has suggested that STS can be seen as an issue-area in policy-making internationally. As such, STS presents itself both in the narrow and the extended sense, i.e., as having a direct and precise relation to policy or an indirect and political-normative influence. The paper then discussed TA as a sub-field of STS. TA mostly sees itself in an indirect, extended relation to policy on three arenas: the state, the market and civil society, but with little emphasis on campaign strategy. Some particular problems for TA were analysed and further developed by applying industrial organisation theory. Within the problem-context of this theory, it was pointed out that TA could be more concerned with: 1) warranty and credible threats in relation to policy-projects that include technical change; 2) imbalances in and around the informal economy; 3) the reputation of actors; and 4) local opportunities and political values.

References

Akerlof, G., 1970, "The Market for Lemons: Qualitative Uncertainty and the Market Mechanism, *Quarterly Journal of Economics*, 83:3.

Andersen, E. & Lundvall B.-A., 1988, "Small national systems of innovation facing technological revolutions: an analytical framework," in Freeman, C. and Lundvall, B.-A., 1988, *Small countries facing the technological revolution*, Pinter, London.

Baark, E., 1991, "Development Technology Assessment – Some theoretical and methodological issues," paper presented at an International Workshop on

Technology Assessment for Developing Countries in Washington, D.C., 7-7 November, 1991.

Coase, R., 1937, "The Nature of the Firm," *Economica*, 4.

Cronberg, T. (1986), *Metoder i teknologivurdering*, Copenhagen, Blytmanns forlag.

Cronberg, T. (ed.) (1989), *Mod på Teknologien, 6 metoder til folkelig teknologivurdering*, Copenhagen, Teknologinævnet.

Cutcliffe, S. H. (1989), "The Emergence of STS as an Academic Field," in *Research in Philosophy & Technology*, vol. 9 (1989), pp. 287-301.

Dahmén, E. (1988), "'Development Blocks' in Industrial Economics," in *Scandinavian Economic History Review*, no. 1, 1988.

Freeman, C. & Perez, C., 1988, "Structural Crises of Adjustment: Business cycles and investment behaviour," in Dosi, G. et al. (eds.), 1988, *Technical Change and Economic Theory*, London, Pinter.

Fuglsang L. & Pedersen, J. S., 1994, "Pro-Active and Strategic Policies of Integration: Toward a New Social Division of Labour in the Baltic Region," chapter in Owsinski, J W (ed.) (1994): *Nordic-Baltic Europe is Restructuring: Looking for the integration fits*, Warsaw: the Interface Institut

Fuglsang, L., 1993, *Technology and New Institutions*, Copenhagen, Academic Press.

Fuller, Steve (1993), *Philosophy, Rhetoric, and the End of Knowledge: Coming of Science and Technology Studies*, Madison, WI : University of Wisconsin Press, 1993.

Illeris, S.,1992, "The Herning-Ikast textile industry: an industrial district in West Jutland," in *Entrepreneurship and regional development*, Vol. 4, nr. 1, 1992, S. 73-84.

Jessop, B.,1993, Structural Competitiveness and Strategic Capacities: Rethinking State and International Capital." in Sjöstrand, S-E: *Institutional Change: Theoretical and Empirical Findings*, New York, M. E. Sharpe.

Leyton, J. & Smits, R., 1993, "The Role of Technology Assessment in Contemporary Technology Policy," Stencil, TNO Centre for Technology and Policy Studies (for publication in the International Journal of Management of Technology).

Lundquist, L, 1987, *Implementation steering : an actor-structure approach*, Lund, Studentlitteratur.

March, J. G. & Olsen, J. P. (1989), *Rediscovering Institutions, The Organizational Basis of Politics*, New York, The Free Press.

Marsh, D. & Rhodes, R. A. W. (eds.), 1992, *Policy Networks in British Government*, Oxford, Clarendon Press.

OECD, 1988, *New technologies in the 1990s: a socio-economic strategy*, OECD, Paris

Powell, W. W. & Dimaggio, P. J. (eds.), 1991, *The New Institutionalism in Organizational Analysis*, Chicago, University of Chicago Press.

Rip, A., 1994, "Opening Address," EASST Conference on Science, Technology and Change: New Theories, Realities and Institutions, Budapest, August 28-31, 1994

Sabel, Ch, 1989, "Flexible Specialization and the Re-Emergence of Regional Economics," in Hirst, P. & Zeitlin, J. (red), *Reversing Industrial Decline*, Berg, Oxford.

Smits, R, 1990, State of the Art of Technology Assessment in Europe, A report to the 2nd European Congress on Technology Assessment – People and Technology: Ways and Practices of Technology Management, Milan, 14-16 November, 1990.

Staudenmaier, J. (1986), *Technology's Storytellers, Reweaving the Human Fabric*, Cambridge MA, MIT Press.

Storper, M. & Walker, R.,1989, The Capitalist Imperative: Territory, Technology, and Industrial Growth, New York, Basil Blackwell.

Symposium, 1991, (Symposium on Organizations and Economics), *Journal of Economic Perspectives*, vol 5, no 2, Spring 1991.

Tirole, J., 1989, *The theory of industrial organization*, Cambridge, Mass. MIT Press, 1989.

Vig, N. J., 1991, "Parliamentary Technology Assessment in Europe," Stencil (For inclusion in Fary Briner, ed. Science, Technology and Politics: Policy Analysis in Congress).

Williamson, O. E. (1975), *Market and Hierarchies*, New York, The Free Press.

PUBLIC PERCEPTION ISSUES: AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY

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The recent introduction and debate surrounding Flavr-Savr^{TM} tomatos and BST milk (bovine somatotropin injections to increase milk production in cattle) have demonstrated the sensitivity of the general public to biotechnology-derived products. Although there is growing recognition of the need to accept and involve the public as a legitimate partner in the biotechnology debate (Fleising, 1991:89-102), such inclusion needs to be preceeded by identification of the specific issues that concern the public (Hagedorn, 1994:24-27). This study identified issues of public perceptions that relate to agricultural and environmental applications of biotechnology.

It has been estimated that many types of engineered animals and hundreds of different engineered crops, fruits, trees, and ornamentals could be commercially available by the turn of the century (Rissler, 1993), and numerous environmental applications of engineered microorganisms are under development as well (Frederick, 1994:529-535). Regardless of the intentions of the biotechnology sector and the potential human benefits, biotechnology can also be constrained and its benefits never fully realized. The voting public, through perceptions of biotechnology, will have a great influence on which direction biotechnology will follow (Lacy et al., 1991). Surveys have indicated that some respondents have a limited and disturbing view of biotechnology. As an example, in one survey less than 25% of the respondents felt they understood introductory science concepts, and they indicated that most of their information on biotechnology was received from television (90%) and newspaper (80%) sources (Zechendorf, 1994:870-875).

In spite of the United States' comprehensive and detailed regulatory system (MacKenzie, 1991:81-93), substantial concerns are still frequently voiced about biotechnology applications relating to environmental impacts, agricultural uses, food safety and labeling issues, and the need for a public voice in the regulatory framework. Such concerns are readily evident in the litigation that surrounded the commercialization of Flavr-Savr^{TM} tomatos, and the recent agreement between the Canadian government and industry to a 12-month voluntary moratorium on the sale of the BST hormone (Yanchinski, 1994:35). Scientific responses of disbelief and disdain to these public concerns--in language often incomprehensible to the majority of citizens--have further exacerbated concerns that science, in its hubris or ignorance, will create agricultural or environmental problems that are virtually impossible to resolve (Buttel, 1991: 307-319).

Study methodology

Surveys were examined to reveal common threads of public concern and perceived attitudes towards biotechnology, and to document public opinions on science education and attitudes about science, the environment, and potential effects of biotechnology. Public perceptions of biotechnology, with emphasis on agricultural and environmental applications, were then explored as they were reflected in the recent popular press. In addition, public perception issue papers from science magazines, journals, books, conference proceedings, and regulatory documents that concerned risk assessment were included and evaluated separately for purposes of comparison to the issues developed from surveys and the popular press.

The issues were generated by tabulating both survey responses and the issues in popular press and newspaper articles, and then compiling the results into common themes through identifying prevalent ideas and collective statements or phrases. Concerns raised from these sources were grouped into related topics by developing a database for biotechnology issues and cross-indexing material to categorize, within topics, both the frequency with which an issue appeared and the degree of importance that survey responses attached to an issue. In this fashion, issues that rarely appeared were eliminated from the process, and a relative level of frequency that an issue appeared (a frequency index) was assigned for each issue on a scale of 1 to 10, with 10 equaling very frequent, 5 equaling moderate frequency, and 1 equaling low frequency. (The frequency index was based on a psychometric modelling technique that has been applied to risk perception analysis--Kemp, 1992:99-114--and was used in this study as an indication of the measure of importance or emphasis of an issue to the general public.) As a check on this approach, the developed issues were compared to those identified in a similar fashion from the scientific literature on biotechnology perceptions and regulatory documents on risk assessment to determine if any substantial issues were being overlooked in the surveys and popular press sources.

Study results

A list of 25 specific issues, and a rating of their relative level of importance, was developed under eight general topics (*e.g.*, foods, animals, plants, etc.) and is presented in Table 1. Specific issues are described in a question form to represent the type of questions most frequently asked about biotechnology by the public. None of the issues are mutually exclusive, and several could have been placed under more than one topic heading.

The issues identified from survey results were broader in both scope and context than those compiled from the popular press articles. Survey questions ranged from general to highly specific and covered a wide range of biotechnology topics, although there was a definite focus on certain issues such as foods, safety, ethics, and education. Biotechnology stories in newspapers tended to focus on health, medical, and ethical issues, and only a small percentage (<25%) were dedicated to agricultural and environmental topics. It was difficult to identify public perception issues from newspaper articles because many were written in dramatic language which frequently promised unlimited

Table 1. Specific public perception issues and relative level of concern on agricultural and environmental biotechnology topics.

	Topic/Issue	Relative Frequency Index*
Genetically engineered foods		
1.	Should genetically engineered foods be labeled?	9.0
2.	Will engineered foods be less expensive and/or more nutritous?	7.0
3.	Are genetically engineered foods safe to eat?	6.5
4.	Will certain genetically engineered foods be considered ethically unacceptable?	3.5
Genetically engineered plants		
5.	Can genetically engineered crops become weeds?	4.0
6.	Could genetically engineered crops invade sensitive habitats and become a threat to native plants?	3.0
7.	Could genetically engineered crops transfer new genes and properties to wild relatives?	2.5
Geneticaly engineered animals		
8.	Will genetically engineered animals present a health hazard to humans?	8.0
9.	Is development of genetically engineering animals ethically acceptable?	6.5
10.	Are animal welfare issues being considered in the development of genetically engineered food animals?	6.0
Genetically engineered microorganisms		
11.	What are the risks to people from large-scale releases of genetically engineered microorganisms?	5.5
12.	Will engineered microbes have any long-term effects on the environment?	4.0
13.	How can an engineered microbe be controlled after release in the environment?	3.5

Social/legal		
14	Will decisions about the use of biotechnology products be made with input from those who will be most directly affected?	8.5
15	What are the ethical and moral concerns with creating engineered organisms?	7.5
16	Why can engineered organisms be patented, and how does patenting impact availability of scientific information?	6.0
17	Will biotechnology contribute to the disappearance of small farms and erosion of rural values?	4.5
Risk assessment/regulations		
18	How adequate are current regulations for assuring public safety?	8.5
19	How can the public have a direct voice in the risk assessment process?	7.5
20	What risks are acceptable for biotechnology, and who can be trusted to explain the risks?	7.0
Education		
21	Will increased knowledge about biotechnology be sufficient to allay fears?	8.0
22	Do television and the popular press accurately depict biotechnology issues?	7.5
23	How can academic responsibility to the public be maintained with increasing commercial support for biotechnology research?	4.5
International		
24	How will public safety be maintained as a result of testing biotechnology products in developing countries with little or no regulatory systems?	6.5
25	How will biotechnology products commercialized in industrialized nations be made available to developing countries?	4.0

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*The frequency an issue appeared in surveys, newspapers, and popular press articles represented as a frequency scale, with 10 = high frequency, 5 = moderate frequency, and 1 = low frequency rewards and/or pointed to unacceptable risks. Asalso described by others (McCabe, 1991:15-24), news stories typically concentrated on unrealistic scenarios (such as the movie *Jurassic Park*--Hood, 1993: n.p.) and had a tendancy towards superficial and incomplete information. Opponents of biotechnology were featured in approximately one-third of the news stories, and threats to people and the environment, unsupported by any scientific evidence, were frequently used in the headlines (Bowermaster, 1992:12). The popular magazine articles were more detailed and better represented both the pros and cons of biotechnology issues. Most were developed in a debate format where proponents and opponents described their positions on a particular biotechnology topic.

By comparison, the biotechnology articles in science magazines tended to be written primarily by scientists or staff writers, and an attempt to uncomplicate scientific issues for a more general audience was apparent. These magazines were the sources of numerous articles on most of the perception issues that were identified from surveys in this study. In comparing the issues obtained from the scientific literature and regulatory documents and examining publication dates, it became apparent that most of the issues were first voiced by the scientific and regulatory communities before they were included as sources of questions in surveys or developed as topics for news stories, and then percieved as concerns by the public. When the influence of these communities is considered, it appears to explain why so many of the public perception issues are inseparable from scientific and regulatory issues (*e.g.*, issues 3, 5, 6, 7, 8, 11, 12, 13, 18, and 20, Table 1). No issues were identified from the scientific and regulatory sources that were not included in the list of public perception issues, with the exception of those few that have emerged only recently from the scientific literature (*e.g.*, transgenic plant viruses).

Conclusions

Because of experience regarding problems encountered with introductions of other technologies, the public has expressed reservations about complete and trusting acceptance of agricultural and environmental biotechnology: they have voiced a strong concern regarding both safety of engineered products and the effects biotechnology will have on their lives (Hoban et al., 1992). This study on perceptions was undertaken in an effort to enhance understanding, or literacy, concerning biotechnology. However, even complete biotechnological literacy will not be able to fully answer some of the issues developed in Table 1. Some cannot be answered solely by scientific expertise but rather by joint consideration of science and moral and societal values (*e.g.*, issues 4, 9, 15, and 20).

This report developed the public's concerns from the public's viewpoint, not from a scientific, industrial, or regulatory view. The intent was neither to advocate nor critique any one segment of biotechnology, but rather to first identify issues of concern to the public and place some level of relative emphasis on the issues. "Concerns" by their very nature have a negative implication, so it is recognized that these public concerns appear to frame each issue within a negative context, regardless of whether or not such context is ultimately appropriate. But identification of concerns is only the first step in addressing these issues of importance to the public.

Scientific and regulatory communities are currently attempting to address public concerns about science in general and biotechnology in particular (Miller, 1992). Close examination of both scientific answers to public concerns (Hagedorn & Hagedorn, 1994) and the results of this study reveal, however, that the scientific community is not always answering the exact questions raised in Table 1. Often public perception issues are addressed from the *scientific*, not the *public*, perspective. In addition, not all the questions raised by a public sensitized to negative as well as positive impacts of technologies can be answered by purely scientific answers. Further exacerbating the problem is the language often found in these scientific answers: the rhetorical practices utilized in science to gain professional credibility often are the exact practices which heighten rather than calm apprehensions on the part of a non-scientifically trained public (Allender-Hagedorn, 1995).

Intentional or not, the public frequently perceives an attitude of professional distain towards their efforts to be involved in the discussion of agricultural and environmental biotechnology. This same public has been the focus of many different biotechnology educational initiatives that call for including the public as a legitimate partner, using the media to develop public awareness, instituting nationwide public school programs, and developing a special infrastructure to meet legitimate public concerns (Lacy et al., 1991:139-161). These initiatives have shown varying degrees of success and/or acceptance. However, the recent successful experience of a 16-member lay panel in the U.K. (O'Brien, 1994:964-965) may serve as a useful model. At its conclusion, this panel reflected a very favorable view towards the potentials of agricultural biotechnology in their report, but also highlighted the need for clear labeling of all biotechnology products, called for better international regulations, closer monitoring of field tests, and criticized current patenting procedures. The panel organizer, Britain's Biotechnology and Biological Sciences Research Council, was impressed with the lay panel's ability to grapple with the complex legal, economic, environmental, and social aspects of biotechnology research.

It is hoped that this study of issues will serve to enhance dialog between 1) the public and 2) scientists in academia, biotechnology industry representatives, and regulatory agency personnel, in an atmosphere of mutual respect. In such a gathering the issues and levels of public concern can be discussed, and potential solutions and specific recommendations can then be formulated to address these issues.

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REFERENCES

Allender-Hagedorn, S. (1995). The rhetoric of biotechnology: Some insight into the tomato wars. Unpublished paper.

Bowermaster, D. (1992, June). Killer tomatoes? U.S. News and World Report, **8**, 12.

Buttel, F.H. (1991). Rethinking biotechnology policy. In C.B. Flora, and J.A. Christenson, (eds.), Rural Policies for the 1990s. Boulder, Co.:Westview Press.

Fleising, U. (1991). Public perceptions of biotechnology. In V. Moses and R.E. Cape, (eds.), Biotechnology: The Science and the Business. Chur, Switzerland:Harwood Academic Publishers.

Frederick, R.J., and M. Egan. (1994). Environmentally compatible applications of biotechnology. BioScience **44**, 529-535.

Hagedorn, S. (1994, Aug.). Science literacy, NBIAP, and public perceptions of biotechnology. Bulletin Science, Technology, and Society **14**, 24-27.

Hagedorn, S., and C. Hagedorn. (1994). Published Recommendations on Biotechnology Issues: A Supplement to the Draft Document on Public Perceptions of Agricultural and Environmental Biotechnology. Unpublished report.

Hoban, T.J., and P.A. Kendall. (1992). Consumer Attitudes About the Use of Biotechnology in Agriculture and Food Production. Raleigh, N.C.:North Carolina State Univ.

Hood, L. (1993, June 3). Covering Jurassic Park. Newsbackground, A Briefing Paper for Journalists.

Kemp, R. (1992). Social implications and public confidence: Risk perception and communication. In D.E.S. Stewart-Tull, and M. Sussman, (eds.), The Release of Genetically Modified Microorganisms. New York:Plenum Press.

Lacy, W.B., L. Busch, and L.R. Lacy. (1991). Public perceptions of agricultural biotechnology. In B.R. Baumgardt, and M.A. Martin, (eds.), Agricultural Biotechnology: Issues and Choices. West Lafayette, Ind.:Purdue Univ. Agricultural Experiment Station.

MacKenzie, D.R., and A.K. Vidaver. (1991). U.S. biosafety regulations: Too much or not enough? In B.R. Baumgardt, and M.A. Martin, (eds.), Agricultural Biotechnology: Issues and Choices. West Lafayette, Ind.:Purdue Univ. Agricultural Experiment Station.

McCabe, A.S., and M.R. Fitzgerald. (1991). Media images of environmental biotechnology: What does the public see? In G.S. Sayler, R. Fox, and J.W. Blackburn, (eds.), Environmental Biotechnology for Waste Treatment. New York:Plenum Press.

Miller, J.D. (1992). The Public Understanding of Science and Technology in the United States, 1990. Washington, D.C.:National Science Foundation.

O'Brien, C. (1994). Lay U.K. panel savors debate. Science **266**, 964-965.

Rissler, J., and M. Mellon. (1993). Perils Amidst the Promise: Ecological Risks of Transgenic Crops in a Global Market. Cambridge, Mass.:Union of Concerned Scientists.

Yanchinski, S. (1994). Bovine Somatotropin protesters focus their efforts on product labeling. Genetic Engineering News **14**(20), 35.

Zechendorf, B. (1994). What the public thinks about biotechnology: A survey of opinion polls. Bio/Technology **12**, 870-875.

CONTROVERSIES OVER EVOLUTION AND CREATIONISM: TOWARD A POSTMODERN HISTORIOGRAPHY OF SCIENCE

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In this paper, I will attempt the application of some elements of postmodern theory to the historiography of science. I will not, however, give a defense of the views of Foucault (1972), Lyotard (1984), Joseph Rouse (1987, 1990, 1991a, 1991b, 1993a, 1993b), Paul Forman (1991), Frank Ankersmit (1989, 1990), Barbara Reeves (1995), Stephen White (1991), and others. Aspects of the work of these scholars provides the foundation for this paper, but space prevents me from giving a detailed enumeration of their important work. In addition, I will not argue in favor of Scientific Creationism. My arguments and recommendations here apply only to the writing of history, to doing history, yet I hope it will be clear that these views have relevance for education, whether it be education in the schools or universities, or in national museums. So let me begin by outlining what I mean by postmodern historiography.

Postmodern Historiography

To illustrate what I take to be postmodern historiography, let us start with Lyotard's (1984) "incredulity toward metanarratives." (p. xxiv) Let me be clear that I take metanarratives in this case to mean historiography, or what I call History-3. Here it is useful to consider what I will call the various levels of history;[1] they are the following:

- **History-0**: 'actual' history; what 'really' happened and why; our epistemic access to this is limited, for obvious reasons
- **History-1**: the evidence we have of history-0, whether documents, films, oral histories, artefacts; or the chronology of events of the past without interpretation
- **History-2**: what historians normally call history; an interpretation or narrative about the past
- **History-3**: what historians call historiography; the norms utilized by historians to interpret history; a metanarrative
- **History-4**: the reasons used to justify choosing or implementing an historiography; for example, what I am arguing here in this paper

So, my position presented here is really a History-4, a meta-metanarrative: a way of structuring appropriate historiographies, or metanarratives. Hence, we *will* have metanarratives--even though Lyotard and Foucault and others instruct us not to take them too seriously, or to doubt their veracity--although we will have only a certain kind. But what kind? Let me enumerate the characteristics of the historiographical stance an historian must adopt to be doing postmodern historiography:

1. The first I have already stated: *incredulity toward metanarratives*, and, I would add, narratives. Holding to the 'truth' or finality of one historical interpretation or historiography amounts to the acceptance of a totalizing metanarrative. The reasons for this position will hopefully become clear.

2. The historian must *question the epistemic authority of science* as a starting point for historical analysis, lest she adopt the metanarrative of modernity, according to which science is unquestionably superior epistemically. This must be replaced with a serious consideration for historical contingency, and how that contingency will be revealed by the historical evidence, that is, History-1.

3. The postmodern historian must be *reflective*. That is, the historian must constantly be evaluating his stance, in a reflective way, in order to purposefully and candidly reveal *how* the historical evidence is supporting the History-2, the interpretation. And, she must evaluate critically *how* the narrative, or History-2 is structuring and using the evidence, History-1. Many historians succeed at these tasks. But most historians, I argue, do not explicitly reveal *how* the History-3, or historiography, is guiding the narrative, the interpretation, or History-2, nor do they worry about History-4, what I am in the process of worrying about right now.

4. Finally, the postmodern historian must *reject internalist historiography and internalist history*. Perhaps the most extreme example of this kind of history comes from the philosopher of science Imre Lakatos (1978a-d), whose notion of the rational reconstruction of the history of science--his metanarrative, or History-3--directs that there be *no connection* between History-1 and History-2, or between the historical evidence and the interpretation of that evidence.

Instead, Lakatos instructs us to adopt a modernist metanarrative, according to which transcendental principles of rationality and progress will determine how history should have occurred, even if it did not turn out that way. In other words, History-1 is irrelevant; the historical *evidence* is irrelevant. I argue that this scheme for doing history lies hidden behind not only attempts to write histories of the controversies over evolution and creationism, but also behind recent attempts--successful attempts--to squash the Smithsonian's interpretation of the atomic bombings of Hiroshima and Nagasaki that was to be displayed in the Air and Space Museum's *Enola Gay* exhibit.

What, then, are we to say about internalist historiography of this sort? If we are not to be constrained by *a priori* principles of rationality and progress that force an 'explanation' that ignores the proper relationship between explanation and History-1 and History-2--one which purports to guarantee a final, definitive 'explanation' in accordance with its very demands for rationality and progress--then one must give up hope of a definitive history of science. Furthermore, so-called internal history of science must be seen for what it really is: *not* history, in any meaningful sense. It reduces to philosophical logico-rationality mongering in the Popperian third world (on Popper's third world, see Popper 1983, chs. 3-4, 8; and Popper 1994), all to save (at the expense of history) the cherished notion of scientific progress. It is an enterprise conducted almost exclusively in Platonic Heaven, with virtually no connection to the spatio-temporal events of the past.[2]

Rationality and the Evolution/Creationism Debates

Turning now to the evolution/creationism controversy of the twentieth century, we find that it can be divided roughly into two parts. First is the controversy over the teaching of evolution in public schools which centered around the 1925 Scopes trial in Dayton, Tennessee. The second began in 1961, when Henry M. Morris and John C. Whitcomb Jr. published *The Genesis Flood: The Biblical Record and Its Scientific Implications*, and, to some extent, still continues today (cf. Numbers 1986, pp. 394-403, 407-15). Both debates presuppose the epistemic superiority of scientific methodology by the key players in *both* sides of the debates. More importantly, historical narratives have consistently taken this position as well.[3]

The emergence of organized opposition to the teaching of evolution was largely due to one person, three-time presidential candidate William Jennings Bryan (1860-1925) (cf. Numbers 1986, pp. 394-8; Szasz 1982, pp. 107-16). Bryan, a respected public figure, became disillusioned over the effect the teaching of evolution seemed to be having on the young people of America. He feared a generation of unbelievers was in the making. Bryan took it upon himself to galvanize support against the teaching of evolution, and he successfully assisted in the case in Tennessee against the high school biology teacher, John Thomas Scopes. While the impact of Scopes' trial and conviction initially resulted in bad press for Bryan's movement (he died a few days later), by the end of the 1920s over twenty states considered anti-evolution laws. Switching tactics, the creationists thereafter focused on local communities instead of state legislatures. Before long, evolution all but disappeared from high school texts (Numbers 1986, pp. 394-402; Grabiner and Miller 1974, pp. 832-7).

From our standpoint, what is interesting here historically is that the tactics of the creationists did *not* involve bashing science. Bryan and his followers did not claim that religious knowledge was on a par with scientific knowledge, and hence 'scientific.' More importantly, they did not argue that scientific knowledge was not as legitimate as scientists claimed it to be. They *did* claim that evolution was not scientific (Numbers 1986, pp. 395-401).

While some recent historical scholarship has shied away from characterizing the evolution/creationism controversies as 'warfare' or confrontation between 'science' and 'religion',[4] there remains implicit in these analyses the presupposition that science (including evolution) is on preferred epistemic ground. In her recent book on the creation controversy, Dorothy Nelkin (1982) identifies the origin of the 1920s controversy as an attack on "modernism" by fundamentalists threatened by social changes brought about by the industrial revolution (pp. 30-1). Evolution was one (if not the main) focus of the attack, since it seemed to most directly challenge fundamentalist belief. So it seems Nelkin is attempting to identify the social context within which the 1920s controversy arose. However, Nelkin makes two claims which we should question critically. First, she slips into talk which characterizes the controversy as a "revolt against science." (pp. 31-2) Second, she claims that the Northern response to the Scopes trial should be seen in its modernist context in which Northerners attempted to *reconcile* evolution, and science in general, to their faith. Nelkin states:

> Indeed among Northerners who had reconciled religion and evolution, the old assumption about the incompatibility of science and religion seemed almost absurd by the time the Scopes trial brought the issue to national prominence. In fact, the trial was not intended to raise this issue at all. Rather, it was provoked by the American Civil Liberties Union [ACLU] in order to show that Tennessee's anti-evolution legislation violated the First Amendment. (pp. 30-1)

Who were these Northerners who had already reconciled evolution to their faith? Nelkin seems to come to this unsupported conclusion partly to account for the lack of horror on the part of these "Northerners" in responding to Scopes' conviction.[5] Nelkin's way out of this modern, internalist quandary is to suppose that it was not a problem for the Northerners since they had long incorporated evolution into their belief system. Clearly, this historiographical escape hatch is employed to rescue some semblance of rationality from this historical episode. For the internalist historiographer, it would be virtually a logical necessity for those who accepted evolution to react in horror when someone is convicted of a crime for teaching it. Here we have a most virulent case of the influence of infiltrating 'external' factors on the rational course of scientific thought [I am being ironic here]. The proponents of science must act accordingly. To suggest otherwise would be tantamount to rejecting the epistemic priority of science--and internalist historiography.

One would hope that Nelkin's interpretation would be supported by at least some historical evidence, and it may be that she is partly right. But she offers no historical evidence to support this contention, and she is not the only one to account for the 1920s controversy in this manner. In his recent account of twentieth century creationism, Ronald L. Numbers (1986) makes a similar assumption.[6] Numbers assures us that at the time of the 1925 Scopes trial, evolution was firmly established in high school biology textbooks (p. 403; cf. also Grabiner and Miller 1974, pp. 832-7; and Larson 1985, chs. 1-3, esp. pp. 15-27 for his attempt to trace the role of evolutionary theory in high school biology textbooks). Such an assumption fits in well with the internalist line only if the creationists are endowed with great powers to affect changes in the content of textbooks. Such an interpretation fosters the view that the creationists were battling science as an established institution.

Recent historical scholarship has shown that several of the above assumptions are misleading at best. In particular, I point to the work of Philip Pauly (1991), who notes that historians have generally assumed that by 1925 evolution was firmly established in high school biology (pp. 663-4, 685-8). Let us consider, briefly, what have been the consequences of the internalist metanarrative for the evolution/creationism controversy of the 1920s. As we have seen, errors in historical judgment have arisen from the attempt to force diverse cultural contexts into one historiographical scheme, a scheme which imposes a context-transcendent principle on past events. The source of the errors is not simply incomplete historical scholarship (for example, the historian did not look at enough sources or at primary sources), it is also the presupposition of rationality in the historical course of scientific thought. The modern, internalist metanarrative removes the central historical explanation from its social context and plants it in the world of disembodied knowledge. This may explain why Nelkin presupposed Northerners had reconciled evolution to their faith and why Numbers presupposed evolution was in 1925 a long-established component of high school biology textbooks.

Scientific Creationism

A plethora of historical (and philosophical) accounts have appeared on the resurgence in the 1970s and 1980s of the legal battles over the teaching of evolution in public schools. These efforts trace some aspect of the story that originates roughly with Whitcomb and Morris' publication of *The Genesis Flood* in 1961, to Morris' role in forming the Creation Research Society in 1963 and then the Institute for Creation Research in 1972, and then to the legal and legislative battles over the teaching of evolution during the next two decades. Most if not all of these accounts fit squarely into the internalist camp.[7] Indeed, in one of these court cases in Arkansas in 1981, the historian and philosopher of science Michael Ruse and the sociologist of science Dorothy Nelkin were used by the ACLU as expert witnesses in arguing against giving creationism equal time in the classroom (Ruse 1984b, pp. 311-42). One may ask, given the obvious sympathies of these two scholars, what are we to make of their historiographical stances? Are we to trust narratives written by scholars who have such a personal, vested interest in one particular side of the debate? Should historiography be a function of taking one side or the other?

The emergence of *scientific* creationism in the 1970s can be distinguished from the 1920s controversy in that the creationists' strategy changed. Instead of arguing that evolutionary theory is not scientific, they began to argue that creationism *is* scientific, and therefore a legitimate scientific theory to be taught alongside evolution in public schools (cf. Numbers 1986, pp. 411-12). This tactic, and particularly the 1981 legislative decisions in Arkansas and Louisiana to teach creationism alongside evolution, put scientists on the defensive (and offensive) in upholding evolutionary theory and discrediting creationism as a science. Around this time, a number of accounts by scientists appeared, aimed at convincing the public of their stand on the issue (see, for example, Eldredge 1982; Futuyma 1983; Godfrey 1983; Lewin 1982; McGowan 1984; National Academy of Sciences 1984; and Walker 1984). While it would probably be unfair to expect unbiased historical scholarship in these accounts, their rhetorical effect on public opinion is potentially as great (or even greater) than accounts written by professional historians. Moreover, the tactics used are not much different from those used by historians and philosophers of science. What is significant, however, is that the rhetoric used fails to meet the standards of contemporary philosophy of science. This is not to suggest that philosophy of science has the last word on the nature of science. We should expect, though, that historically inaccurate metatheories not be resurrected in the defense of an untenable view of science.

For example, in his testimony in the 1981 Arkansas case, Michael Ruse (1984b) invoked Popperian falsification as a tenet of scientific methodology that evolution met while creationism failed (pp. 311-42). In the decision in favor of the plaintiffs, Judge William R. Overton cited falsificationism as one of the "essential characteristics of science." (quoted in Wilson 1983, p. 213; for the entire decision, see Overton 1982) These characteristics, derived from decades-old philosophy of science were enumerated as follows:

(1) It is guided by natural law;
(2) It has to be explanatory by reference to natural law;
(3) It is testable against the empirical world;
(4) Its conclusions are tentative, i.e., are not necessarily the final word; and
(5) It is falsifiable. (quoted in Wilson 1983, p. 213)

One point the expert witnesses drove home in their testimony was that the creationists used scientific evidence and statements by scientists selectively in order to support the scientific status of the theory of scientific creationism, or to weaken the status of evolutionary theory (Ruse 1984b, pp. 331-6). Michael Ruse recalled that he "wanted to prove not merely that Creation-science is not science, but that it is a dishonest and thoroughly corrupt enterprise, violating every standard of intellectual integrity." (p. 331) Indeed, Ruse claims that he "was able to show that statements made by eminent evolutionists were lifted by creation-scientists and quoted out of context. Evolutionists [were] made to say the very opposite of what they intended." (pp. 331-2)[8] Judge Overton agreed (cf. Wilson 1983, pp. 214-8).

While Ruse is clearly correct in his assessment of the tactics of the scientific creationists, what are we to make of *his* tactics and those of his fellow expert witnesses? Does utilizing an outdated and historically suspect account of scientific change amount to intellectual honesty?

The tactics of the Arkansas case plaintiffs are repeated in other historical, philosophical, and scientific accounts of this controversy. In a publication by the Paleontological Society (Schwimmer 1984), the following criteria are enumerated which scientists must follow in order for their activity to be deemed scientific: Presentation of Multiple Hypotheses; Objectivity; Positivism; Falsifiability; Occam's Razor; and Logical Validity (p. 7). In contrast, the "logical fallacies" committed by the creationists, which make their work unscientific, are: factual error; complex questions and spurious correlations; false assumptions; and anachronisms (pp. 7-8). (Note the use of lower case letters for these "fallacies," while the tenets of the 'scientific method' are capitalized.)

In regard to these "fallacies," we have seen each one of them committed (not necessarily intentionally) by professional scholars in evaluating the evolution/creationism debate historically, philosophically, or sociologically. I argue that a major cause of these problems is internalist historiography. This metatheory of science which guides narratives with a transcendental principle of rationality (embodied in such notions as *the* scientific method, scientific progress, etc.) must be rejected as a methodology for historians, philosophers, sociologists, and all those who study science. But if internalism is to be rejected, with what do we replace it? My answer is postmodern historiography.

Revisiting the Evolution/Creationism Debates

Let me now briefly outline how historians have pursued and might continue to pursue a postmodern historiography in order to reevaluate the evolution/creationism debates. For the 1920s Scopes trial, the historian Philip Pauly (1991) has investigated the origins of high school biology. Contrary to the assumptions of the internalists, Pauly shows that evolution was not an established component of biology teaching before 1925. Furthermore, it was not even on the New York state biology syllabus--and New York educators had a major influence on national high school biology curricula (pp. 685-6). According to Pauly, "[t]his seeming inconsistency becomes comprehensible when one sees evolution as an issue comparable to field study, vivisection, or sex," sticky issues for which educators thought the teaching of biology could provide a forum to better inform high school students of life lessons (p. 686). As for the 'content' of contemporary evolutionary theory,

> instruction on evolutionary mechanics seemed impossible in the 1910s and 1920s given the degree of professional uncertainty about the mutation, selection, and inheritance of acquired characters. What was important was to convey an evolutionary perspective, but this task was largely independent of specific instruction about species change. (p. 687)

It should be no surprise, then, that no furor erupted among biology teachers as a result of Scopes' conviction. Pauly states that "New York educators periodically and routinely noted that teaching evolution could disturb the classroom or the community, and they saw little value in antagonizing potentially vocal elements of the public." What was more important to the educators was their view of the kind of person they aimed, through biology teaching, to produce--liberal, secular, and humanist (p. 686). Given that evolution played a minor role in this effort, and given that they were successful in their efforts, the reception of Scopes' conviction is no longer an historical mystery. The power of the creationists in changing course content is also put into proper perspective:

> Biology educators were more cunning than timid, maneuvering within limits set by their perception of the state of scientific knowledge, their experience in urban classrooms, and their assessment of individual and collective power. They prevailed in the struggle that mattered to them most. High school biology became part of public education throughout the country, and its fundamental themes and images became part of middle-class culture. Their view of life was coherently masculine, urban, and liberal. (p. 687)

Pauly's historiography clearly rejects the assumptions of modernity. Internalism is abandoned, and the historical mysteries generated by Nelkin (1982) and Numbers (1986) in their rationalist accounts, become comprehensible from the postmodernist standpoint.

As for the 1970s and 1980s version of the debate, the implications of postmodernist historiography should be clear. While no adequate historical account, to my knowledge, has been written, we can point to some guidelines that should be followed. First, the metanarrative of each side should be made clear. As the evolutionists point to the intellectual dishonesty of the scientific creationists, so too must the postmodern historian bring up front the scientific rationality of the evolutionists and "pull the carpet out from under the feet of science and modern[ity]." (Ankersmit 1989, p. 142) Again, this does not amount to accepting creationism as truth, nor does it entail bashing science. It means, in this case, recognizing that education is a key underlying issue. Just as the creationists worried about the effects the teaching of evolution could have on future generations of children, so too were the evolutionists worried about the effects of teaching creationism. Each side wanted to propagate its own worldview. The evolutionists mustered whatever arguments they could to defeat the creationists, even if this involved historically and philosophically questionable, if not inaccurate, philosophical dogma. This story is waiting to be written. Again, it should not be an anti-science story. It should be, in the spirit of Pauly, an analysis which remains ascientific. As Ankersmit[9] rightly states:

> Postmodernism does not reject scientific historiography, but only draws our attention to the modernists' vicious circle which would have us believe that nothing exists outside it. However, outside it is the whole domain of historical purpose and meaning. (p. 153)

In Defense of Martin Harwit

The ongoing debate over the planned *Enola Gay* exhibit at the Smithsonian Institution's National Air and Space Museum exemplifies a crucial problem for the historian of recent history: that participants' histories (or oral histories) are not often the most reliable or balanced interpretations of past events. Seemingly, this statement presupposes that a cogent enumeration of "reliable" or "balanced" facts can be given that is in some sense objective, or that all participants can agree upon. However, this ambition is misguided, as are many of the criticisms of the museum's director, Martin Harwit. Ultimately, the problem rests upon our inability to directly access historical reality.

Critics of Harwit, including Air Force veterans ("Mission That Ended the War," 1994) and a *Washington Post* editorial ("Context and the Enola Gay," 1994) have accused him of various historical and historiographical evils, including not presenting "the full story," engaging in bad "historical revisionism," and in believing that his historiographical constraints are "universal, 'objective' assumptions that all thinking people must share." At stake is the ideologically charged decision that must be made concerning what historical interpretation to give the atomic bombings of Hiroshima and Nagasaki in the *Enola Gay* exhibit. The choices have been characterized by some in stark black and white terms: either present an exhibit that proclaims, "Thank God for the atomic bomb," or present one that fosters the view that "Anti-Asian racism, long a factor in American life," was behind the atomic bombings.

What the critics of Harwit share in terms of their historiographical stances is adherence to the transcendental notion that a definitive history can be written. This position is part and parcel to the perspective of modernity, guided by its metanarrative that instructs historical interpretation. The metanarrative amounts to the view that we can have direct access to reality (including historical reality), unfiltered by gaps in crucial evidence and unencumbered by cultural, political, or ideological trappings. It is this modern perspective to which Harwit (1994) refers when he characterizes his opposing position as "more analytical, critical in its acceptance of facts and concerned with historical context." (p. C9) Yes, the museum should endeavor to tell "the full story" of the bombings, and it should not be simply an "opinion piece." It should aim at the presentation of an exhibit that offers "the basic information that visitors will need to draw their own conclusions." Yet all should recognize that unless the exhibit presents only uncaptioned pictures and artifacts with perhaps names and dates, the exhibit--like all historical narratives--will be an *interpretation* of past events.

The controversy over the *Enola Gay* exhibit now reduces to a debate over historiography. The choice is between the modernist's metanarrative--with its transcendental link to 'actual' and 'definitive' accounts of the past--on the one hand, and the postmodernist's rejection of the 'truth' of the totalizing metanarrative, on the other hand. The latter view is the more coherent historiography, for reasons that amount more to common sense than to the alleged "intellectual sophistication" of elitist academics. Because our knowledge of the past--whether it be in the form of written evidence, films, artifacts, recollections, or the thought processes in President Truman's head--is inevitably incomplete, historians must eschew any hope of writing definitive histories. History is written anew each generation.

The historiographical lesson here is that many of the critics of Harwit have defeated their own purposes of having their viewpoints included in the *Enola Gay* exhibit by adhering to historiographical transcendence. By clinging to an objectivist metanarrative and arguing that their evidence guarantees historical 'truth,' once and for all, these critics betray the very contentiousness of historical interpretation that they take great pains to point out when criticizing Harwit. The major historical questions generated by the exhibit are those that are most subject to tendentiousness--for example, whether the atomic bomb was necessary to end the war with Japan, whether an invasion would have been necessary without it, whether Truman dropped the bomb to impress Stalin, whether it was morally wrong and inhumane to use atomic weapons when conventional weapons might have forced Japan's surrender.

Hence, it is unfair of critics (including the *Post* editors) to suggest that Harwit is unable to "perceive that political opinions are embedded in the exhibit. . . ." There could be no exhibit without them. To suggest, as did one veteran, that the Air and Space Museum "was not established to be a center for political, philosophical, sociological or ethnic discourse," is tantamount to claiming that a definitive and objective (in the transcendental sense) presentation is possible. The problem with this view is that such an exhibit would be shorn of all aspects of its historical context--something the critics of Harwit claim they want more of, or a better version of. The result would be a B-29 aircraft and other artifacts and pictures placed in a room, with no accompanying contextual information to help *interpret* the past. Clearly, this would not be *history*, as contentious as it is. It would not be a "factual and honest explanation" of the *Enola Gay* and the atomic bombings of Japan.

I will let the historian Kai Bird (1995) have the last words:

> Nothing is more debilitating to our national discourse than the notion that history is a known commodity, frozen in time, to be handed untouched from generation to generation. History is a living thing, and it is the wholly legitimate task of historians to be constantly modifying and rewriting it based on new evidence, obtained in large measure from the archives.
>
> Unfortunately, too many Americans want their history simple and unadorned by archival evidence, served up by court historians and written with one goal in mind: the propagation of patriotically correct mythology.
>
> This is particularly true of those defenders of the conventional wisdom on Truman's decision to use the atomic bomb without warning on the largely civilian population of Hiroshima.
>
> I could refute each of the points made by [those defenders] with archival documents, diary quotes and statements from Truman and his closest military advisers.
>
> But that would be tedious; instead I refer readers to a large body of scholarly articles and books written by Barton J. Bernstein, Martin J. Sherwin, Gar Alperovitz, . . . Stanley Goldberg, Gregg Herken, Herbert Feis, McGeorge Bundy, [and so on]. One cannot read these historians without concluding that the decision-making behind the Hiroshima bombing is a still-unsolved--and fascinating--mystery story. (p. 14)

NOTES

1. Kragh (1982, ch. 2) points out the distinction between History-1 and History-2, that is, his distinction between actual history and historical interpretation. His distinction, however, corresponds to History-0 and History-3, respectively, in this paper.

2. Palmer (1993) skillfully argues that Lakatos' rational reconstructions have been unfairly judged by many, including Kuhn, Feyerabend, and Hacking. However, in arguing that his internal historiography may lead to meaningful historical interpretation, Palmer uncritically accepts certain precepts, including the use of privileged rationality as an historiographical guide, progress as a feature of the growth of scientific knowledge, and the notion that scientists themselves know "much better than philosophers what is and what is not scientific. . . ." (p. 617) A key to Palmer's philosophy of science can be seen in his contention that we may find "fuller conceptions of scientific practice" in Kitcher (1993) and Laudan (1984) (p. 620, n. 18). Fuller (1994) harshly criticizes Kitcher's book, which unapologetically advocates progress and realism in science.

3. For discussions on 'internal' and 'external' history of science, and on the demarcation between 'science' and 'nonscience' (or 'pseudoscience'), see Popper (1963), Brush (1974), Lakatos (1987a, 1978d), Shapin (1982, 1992), Pitt (1983), and Palmer (1993). Laudan (1983) and Dolby (1987) explicitly take up the evolution/creationism debates in this context.

4. See, for example, Brooke (1991). For a critical analysis of the 'warfare' historiography, exemplified by Draper (1875) and White (1896), see Moore (1979), esp. chs. 1-4.

5. Nelkin (1982) provides little documentation for her conclusions here. Her historiographical stance places her firmly within the modern, internalist perspective, according to which science proceeds relatively autonomously by virtue of its epistemically superior grounds. Her motivation is likely due to the fact that her book focuses on contemporary (1970s, 1980s) debates over the teaching of evolution in schools. She is clearly on the pro-science side of the debate. On her commitment to the internalist historiographical perspective, see, for example, her comments in ch. 12, esp. pp. 188-189. She even goes as far as to say: "Historically and methodologically, much of science developed in opposition to the dogmatism of religion. . . ." (p. 189)

6. I have used the chapter by Ronald Numbers (1986) as a guide for this paper. His chapter was originally prepared for the Carner Foundation/University of Wisconsin conference on "Christianity and Science," held from 23 to 25 April 1981. This puts the conference squarely within the height of the recent debates over the teaching of evolution and creationism in schools. A shorter version of Numbers' chapter appeared in 1982 (Numbers

1982). Numbers' (1992) book on scientific creationism provides a wealth of historical detail on the various episodes.

7. See, for example, Grabiner and Miller (1974); Kitcher (1982); Nelkin (1982); Newell (1982); Ruse (1982); Frye (1983); LaFollette (1983); Zetterberg (1983); Wilson (1983); Montagu (1984); Numbers (1986); Rohr (1988); Ruse (1988); Berra (1990); and Eve and Harrold (1991). In his laudatory review of Kitcher (1982), Ruse (1984a) characterizes scientific creationism as follows: "[W]hat a hollow sham modern day Creationism really is: crude, dogmatic, Biblical literalism, masquerading as genuine science, in order to avoid the strictures of the first amendment to the U.S. Constitution, which bars the teaching of religion in schools." (p. 348)

8. This charge is undoubtedly largely accurate. A recent publication by the Jehovah's Witnesses (1985), which purports to be a "thoroughly researched examination of how life got here--and what this means for the future," (from inside title pg.) repeatedly takes quotations out of context and misrepresents the scientific evidence.

9. Ankersmit's (1989) article on postmodern historiography was sharply criticized by Zagorin (1990), who remarked: "What stands out in Ankersmit's postmodernist concept of historiography is its superficiality and remoteness from historical practice and the way historians usually think about their work. It trivializes history and renders it void of any intellectual responsibility." (p. 266) Ankersmit (1990) defended his article, maintaining that "at the level of the historical text and of historical interpretation, we cannot appropriately use the words truth and falsity. For we can say a lot of things about proposals, for example, that they are fruitful, well-considered, intelligent, to the point (or not), and so on, but not that they are true or false. . . . [T]he fact that proposals cannot be either true or false does not imply that no good reasons can be given for or against a certain proposal. The mere fact that we cannot label narrative interpretations or narrative substances as either true or false does not in the least leave us empty-handed in historical debate. It is a fallacy as silly as it is dangerous to believe that we can or ought to restrict historical interpretation and historical argument to what can truthfully be said about the past on the basis of available evidence." (p. 282)

REFERENCES

Ankersmit, Frank R. (1989) "Historiography and Postmodernism," History and Theory 28: 137-153.

Ankersmit, Frank R. (1990) "Reply to Professor Zagorin," History and Theory 29: 275-296.

Berra, Tim M. (1990) Evolution and the Myth of Creationism: A Basic Guide to the Facts in the Evolution Debate. Stanford: Stanford University Press.

Bird, Kai (1995, 12 February) [Letter to the editor]. The Washington Post Book World, p. 14.

Brooke, John Hedley (1991) Science and Religion: Some Historical Perspectives. Cambridge: Cambridge University Press.

Brush, Stephen G. (1974) "Should the History of Science be Rated X?" Science 183: 1164-1172.

"Context and the Enola Gay." (1994, 14 August) [Editorial]. The Washington Post, p. C8.

Dolby, R. G. A. (1987) "Science and Pseudo-science: The Case of Creationism," Zygon 22: 195-212.

Draper, John William (1875) History of the Conflict Between Religion and Science. New York: D. Appleton and Company.

Eldredge, Niles (1982) The Monkey Business: A Scientist Looks at Creationism. New York: Washington Square Press.

Eve, Raymond A. and Harrold, Francis B. (1991) The Creationist Movement in Modern America. Boston: Twayne Publishers.

Forman, Paul (1991) "Independence, Not Transcendence for the Historian of Science," Isis 82: 71-86.

Foucault, Michel (1972 [1969]) The Archaeology of Knowledge. Trans. Smith, A. M. Sheridan. London: Tavistock.

Frye, Ronald Mushat (1983) Is God a Creationist? The Religious Case Against Creation-

Science. New York: Charles Scribner's Sons.

Fuller, Steve (1994) "Mortgaging the Farm to Save the (Sacred) Cow," [Review of Kitcher, Philip, The Advancement of Science: Science Without Legend, Objectivity Without Illusions]. Studies in History and Philosophy of Science 25: 251-261.

Futuyma, Douglas J. (1983) Science on Trial: The Case for Evolution. New York: Pantheon Books.

Godfrey, Laurie R., ed. (1983) Scientists Confront Creationism. New York: W. W. Norton.

Grabiner, Judith V. and Miller, Peter D. (1974) "Effects of the Scopes Trial," Science 185: 832-837.

Harwit, Martin (1994, 7 August) "The Enola Gay: A Nation's, and a Museum's Dilemma," The Washington Post, p. C9.

Jehovah's Witnesses (1985) Life--How Did it Get Here? By Evolution or by Creation? Brooklyn, NY: Watchtower Bible and Tract Society of New York, Inc. and International Bible Students Association.

Kitcher, Philip (1982) Abusing Science: The Case Against Creationism. Cambridge, MA: MIT Press.

Kitcher, Philip (1993) The Advancement of Science: Science Without Legend, Objectivity Without Illusions. New York: Oxford University Press.

Kragh, Helge (1982) An Introduction to the Historiography of Science. Cambridge: Cambridge University Press.

Lakatos, Imre (1978a) The Methodology of Scientific Research Programmes: Philosophical Papers, Volume 1. Ed. Worrall, John and Currie, Gregory. Cambridge: Cambridge University Press.

Lakatos, Imre (1978b) "Falsification and the Methodology of Scientific Research Programmes," in Lakatos (1978a), pp. 8-101.

Lakatos, Imre (1978c) "History of Science and Its Rational Reconstructions," in Lakatos (1978a), pp. 102-138.

Lakatos, Imre (1978d) "Popper on Demarcation and Induction," in Lakatos (1978a), pp. 139-167.

Lakatos, Imre and Zahar, Elie (1978) "Why Did Copernicus's Research Programme Supersede Ptolemy's?" in Lakatos (1978a), pp. 168-192.

Laudan, Larry (1984) Science and Values. Berkeley: University of California Press.

Laudan, Rachel, ed. (1983) "The Demarcation Between Science and Pseudo-science," Working Papers in Science and Technology 2:1 Blacksburg, VA: Center for the Study of Science in Society, Virginia Tech, April 1983.

LaFollette, Marcel C. (1983) Creationism, Science, and the Law: The Arkansas Case. Cambridge, MA: MIT Press.

Larson, Edward J. (1985) Trial and Error: The American Controversy over Creation and Evolution. New York: Oxford University Press.

"The Mission That Ended the War." (1994, 14 August) [Letters to the editor]. The Washington Post, p. C9.

Lewin, Roger (1982) Thread of Life: The Smithsonian Looks at Evolution. Washington, D.C.: Smithsonian Books; New York: W. W. Norton.

Lyotard, Jean-François (1984 [1979]) The Postmodern Condition: A Report on Knowledge. Trans. Bennington, Geoff and Massumi, Brian. Minneapolis: University of Minnesota Press.

McGowan, Christopher (1984) In the Beginning--A Scientist Shows Why Creationists are Wrong. Buffalo, NY: Prometheus Books.

Montagu, Ashley, ed. (1984) Science and Creationism. Oxford: Oxford University Press.

Moore, James R. (1979) The Post-Darwinian Controversies. Cambridge: Cambridge University Press.

Morris, Henry M. and Whitcomb, John C., Jr. (1961) The Genesis Flood: The Biblical Record and Its Scientific Implications. Philadelphia: Presbyterian and Reformed Publishing Company.

National Academy of Sciences (1984) Science and Creationism: A View from the National Academy of Sciences. Washington, D.C.: National Academy Press.

Nelkin, Dorothy (1982) The Creation Controversy: Science or Scripture in the Schools. New York: W. W. Norton.

Newell, Norman D. (1982) Creation and Evolution: Myth or Reality? New York: Columbia University Press.

Numbers, Ronald L. (1982) "Creationism in 20th Century America," Science 218: 538-544.

Numbers, Ronald L. (1986) "The Creationists," in Lindberg, David C. and Numbers, Ronald L., eds., God and Nature: Historical Essays on the Encounter Between Christianity and Science. Berkeley: University of California Press, pp. 391-423.

Numbers, Ronald L. (1992) The Creationists. New York: A. A. Knopf.

Overton, William J. (1982) "Creationism in Schools: The Decision in McLean versus the Arkansas Board of Education," Science 215: 934-943.

Palmer, Eric (1993) "Lakatos's 'Internal History' as Historiography," Perspectives on Science: Historical, Philosophical, Social 1: 603-626.

Pauly, Philip J. (1991) "The Development of High School Biology: New York City, 1900-1925," Isis 82: 662-688.

Pitt, Joseph C. (1983) "The Epistemological Engine," Philosophica 32: 77-95.

Popper, Karl (1963) Conjectures and Refutations: The Growth of Scientific Knowledge. London: Routledge and Kegan Paul.

Popper, Karl (1983 [1972]) Objective Knowledge: An Evolutionary Approach. Rev. ed. Oxford: Clarendon Press.

Popper, Karl (1994) "A Pluralist Approach to the Philosophy of History," in Popper, Karl, The Myth of the Framework: In Defence of Science and Rationality, ed. Notturno, M. A. London: Routledge.

Reeves, Barbara J. (1995) "Can We Imagine Postmodern Sciences?" Presentation at Thursday Lunch Discussion Seminar, Center for the Study of Science in Society, Virginia Polytechnic Institute and State University, Blacksburg, VA, 19 January 1995.

Rohr, Janelle, ed. (1988) Science and Religion: Opposing Viewpoints. St. Paul, MN: Greenhaven Press.

Rouse, Joseph (1987) Knowledge and Power: Towards a Political Philosophy of Science. Ithaca, NY: Cornell University Press.

Rouse, Joseph (1990) "The Narrative Reconstruction of Science," Inquiry 33: 179-196.

Rouse, Joseph (1991a) "Philosophy of Science and the Persistent Narratives of Modernity," Studies in History and Philosophy of Science 22: 141-162.

Rouse, Joseph (1991b) "The Politics of Postmodern Philosophy of Science," Philosophy of Science 58: 607-627.

Rouse, Joseph (1993a) "Foucault and the Natural Sciences," in Caputo, John and Yount, Mark, eds., Foucault and the Critique of Institutions. University Park: The Pennsylvania State University Press, pp. 137-162.

Rouse, Joseph (1993b) "What Are Cultural Studies of Scientific Knowledge?" Configurations 1: 1-22.

Ruse, Michael (1982) Darwinism Defended: A Guide to the Evolution Controversies. London: Addison-Wesley.

Ruse, Michael (1984a) "Critical Notice: Philip Kitcher, Abusing Science: The Case Against Creationism," Philosophy of Science 51: 348-354.

Ruse, Michael (1984b) "A Philosopher's Day in Court," in Montagu, Ashley, ed., Science and Creationism. Oxford: Oxford University Press, pp. 311-342.

Ruse, Michael (1988) The Darwinian Paradigm: Essays on its History, Philosophy, and Religious Implications. London: Routledge.

Schwimmer, David (1984) "Is There Scientific Method in Creationism Madness?" in Walker, Kenneth R., ed., The Evolution-Creation Controversy: Perspectives on Religion, Philosophy, Science and Education. The Paleontological Society, Special Publication No. 1.

Shapin, Steven (1982) "History of Science and Its Sociological Reconstructions," History of Science 20: 157-211.

Shapin, Steven (1992) "Discipline and Bounding: The History and Sociology of Science as Seen through the Externalism-Internalism Debate," History of Science 30: 333-369.

Szasz, Ferenc Morton (1982) The Divided Mind of Protestant America, 1889-1930. Huntsville: University of Alabama Press.

Walker, Kenneth R., ed. (1984) The Evolution-Creation Controversy: Perspectives on Religion, Philosophy, Science and Education. The Paleontological Society, Special Publication No. 1.

White, Andrew Dickson (1896) A History of the Warfare of Science with Theology in Christendom. London: Macmillan.

White, Stephen K. (1991) Political Theory and Postmodernism. Cambridge: Cambridge University Press.

Wilson, David B., ed. (1983) Did the Devil Make Darwin Do It? Modern Perspectives on the Creation-Evolution Controversy. Ames, IA: Iowa State University Press.

Zagorin, Perez (1990) "Historiography and Postmodernism: Reconsiderations," History and Theory 29: 263-274.

Zetterberg, J. Peter, ed. (1983) Evolution Versus Creationism: The Public Education Controversy. Phoenix, AZ: Oryx Press.

MATHEMATICS: AN IMPORTANT INTERFACE LANGUAGE FOR STS

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Mathematics is a fundamental language of technology which should be integrated into any study of science, technology, and society. When teachers in any discipline teach their subjects in isolation, the students do not develop a holistic view of how knowledge can be applied in the real world. When teachers in subjects other than mathematics lead their students in the study of topics which have a mathematical basis but without consulting the mathematics experts in their schools, they take the risk of confusing students with alternate (or even substandard) approaches. Likewise, when the mathematics teacher presents mathematical formulas and operations in isolation in a sterile environment without life relevant examples, students neither learn to apply what they learn nor are they motivated to learn it well. This paper helps teachers in all disciplines accomplish more effective integration of STS precepts in their curricula by illustrating the importance of mathematics as an interface language of technology. Additionally, mathematics teachers will be shown ways to relate their subject matter more effectively to our evolving world.

The Problem: Lack of Coordination

The school is a bureaucratic organization with all of the implications which that label entails. Teachers on the firing line frequently complain about the right hand of the administration not knowing what its left partner is doing, but they fail to see that they are themselves guilty of this as well. More importantly, the bungles made by administrative bureaucratic miscues may not be nearly as harmful as those made by the teachers. It does not much matter that Johnny gets counted absent from Algebra I one day due to a quirk in the attendance keeping system, but if he fails to learn a simple application of some important mathematical concept in everyday living (or worse yet, he learns it incorrectly!), there is great potential for harm.

Exploring mathematical concepts in historical and contemporary settings from many fields is the goal of many mathematics courses designed for liberal arts students and as electives for mathematics majors in college and in some progressive high schools. Some examples of the broad range of topics that are explored in these courses include:

- Apportionment--government or history
- Voting theory--government, social choice, sports, the arts
- Fair division--social studies, social choice
- Routing problems--economics, business, management
- Networking--electronics, business, conservation
- Geometry in Nature--biology, art
- Cryptography and encoding--communications, technology
- Probability and statistics--science, technology, communications
- Game theory--social studies, sports, business

These topics along with others help students gain appreciation of math as a model of the world (Steen, 1994; Tannenbaum & Arnold, 1992). Could many of these and similar topics be explored in other subjects within the school curriculum with the help of the mathematics teacher?

Two Approaches to Teaching Mathematics in Content Areas

There are two fundamentally different methodologies which may be used in teaching mathematics in the content areas. They are the "engineering school model" and the "concepts to math approach". The following example from a high school electronics class illustrates the differences. In the engineering school model:

> The students read (or fail to read) the assigned chapter on Ohm's Law in their textbooks. The chapter is as long as twenty or so pages and it contains (typically) Watt's Law, series and parallel circuits, and Kirchoff's Laws as well. It is one of the earliest chapters in the book. The teacher then either gives one or two long lessons to cover the entire chapter, or divides the lessons into smaller bits which appear fragmented in relation to the textbook chapter. The concepts concerning the crucial relationship between voltage, current, and resistance are presented mainly in terms of various formulas for Ohm's and Watt's Laws--as if merely seeing the formula: I=E/R will "naturally" produce an understanding in the students' minds that the current will increase with increasing voltage and decrease with increasing resistance. (Haynie, 1986B, p. 30)

Contrived as this may seem, it is the most often used method for teaching one of the most crucial relationships in electronics. This engineering school model is efficient and a good one to use if the students possess and use well the language of mathematics. Mathematics is a language with its own alphabet (symbols), grammar and syntax (rules and conventions), and stories to tell (logic and relationships). When students from foreign countries come to the United States, we offer them special English as a Second Language (ESL) programs to help them prepare to be able to learn from a new language. Teaching students who are not fluent in the language of mathematics via the engineering school model is as doomed to failure as teaching history to non-English speaking students in English (Haynie, 1986B).

The alternative is the "concepts to math approach". In this method, the electronics teacher would first divide the above section into smaller bite-sized bits and have students read accordingly. Then, instead of presenting the formulas first, the teacher would illustrate the concepts of Ohm's Law--probably without even giving credit to Ohm at first. Once students are exposed to the principle that more electrical pressure (voltage) will cause more current to flow (rate of flow), and more resistance will decrease current, then this knowledge may be used to develop the formulas in class--show the students how the formula explains the relationship and makes it useful instead of trying to teach the concept through the formula. In the best of all possible scenarios, students would actually do hands-on experiments in which they saw the principles and concepts at work without any attempt to quantify the values. For example: If one cell makes the light burn dimly, what will happen with two cells? What would happen if we put two bulbs in the circuit? Then the experiment could be made more sophisticated to include meters, actual values of voltage and current associated with the cells, and the working of the appropriate formulas. This methodology has been shown to be very effective in the classes of one of the authors.

Admittedly, not every topic can be approached this way due to the longer time that it takes to do so. However, if the earliest topics are taught this way and students begin to learn the math through the concepts, then they will acquire the language of mathematics to a degree of fluency which allows the more efficient engineering school model to be used except when very new ground is being broken. We advocate using the concepts to math approach in nearly all cases in the content courses when presenting mathematically based topics and using it in mathematics classes as often as time permits and whenever novel topics are being considered. Recent literature in mathematics journals evidences some agreement by many professionals in the field that this approach is gaining favor even among those who once presented topics in a very sterile manner.

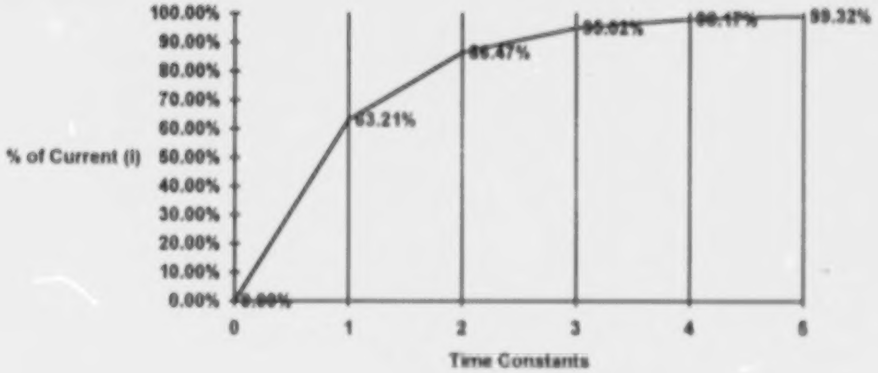
What Are the Mathematics Experts Saying?

The National Council of Teachers of Mathematics (NCTM) has taken some relatively strong stands against the age-old practice of teaching mathematics in isolation. In their Curriculum and Evaluation Standards for School Mathematics, a 258 page document compiled by the NCTM Commission on Standards for School Mathematics, they frequently call attention to this concern. They believe that students should *"Learn to value mathematics.* Students should have numerous and varied experiences related to the cultural, historical, and scientific evolution of mathematics so that they can appreciate the role of mathematics in the development of our contemporary society and explore relationships among mathematics and the disciplines it serves: the physical and life sciences, the social sciences, and the humanities." (NCTM, 1989, p. 5) Though the true mathematicians among us must be well equipped to deal with high levels of abstraction and a very complex theoretical framework--to study mathematics in isolation as well as in context--it is not appropriate for all students to learn mathematics in isolation. The other four goals for students recommended by the NCTM standards include: *"Becoming confident in one's own ability. Becoming a mathematical problem solver. Learning to communicate mathematically.* and *Learning to reason mathematically."* (NCTM, p. 6) If mathematics teachers can change their approach to the extent recommended in these standards, students' views of mathematics as an isolated set of exercises will evolve to reveal mathematics to them as a basic interface language for all human endeavor--how much more fully could the goals of STS be accomplished with students who are fluent in this fundamental language?

Two Examples from Real Life

One of the authors' children came home one night with two homework assignments which should have been related to each other but were not. More importantly, both assignments, one from an economics unit in a social studies course and the other from physical science, had significant overlap with a topic to be studied that term in the mathematics course his group was taking, but there was no coordination of effort by any of the three teachers involved. The mathematics teacher presented the information several weeks later in the usual sterile environment with no meaningful examples and the two other teachers each used differing methodology to present their topics and confuse the children. Luckily, our son had a mathematics teacher to tutor him at home and he made the important connections and saw the "big picture". The economics lesson was on supply and demand (demand VS price, and supply VS price) and the science lesson concerned temperature VS volume and pressure VS volume. What better examples could one imagine of direct and inverse proportions in real life? Wouldn't the students have gained much more if the social studies, science, and mathematics teachers had all corroborated to present these units in the same manner instead of by three different approaches, had all used similar formats and symbolism (or at least been able to show the students why a different symbol applied in their area), and had shared their examples to reinforce each others' efforts?

The second example is from electronics. Frequently in teaching basic electronics courses, time constants are used to facilitate teaching about the amount of current which will flow at any given instant in time in an inductive circuit. For example, if a circuit has both a resistor and an inductor (coil), the current in the circuit will not reach its full value as soon as the switch is closed as it would in a circuit with resistance only. This is because it takes time for the changing magnetic field around the coil to build to its full intensity and all the while that it is increasing in strength it greatly resists the flow of current. The curve which illustrates this slow growth to an eventual level that is considered full current flow (but which is never truly achieved) is shown below:



The time constants are of a set duration which differs for each circuit according to two variables: the value of resistance and the value of inductance in this formula:

t = L/R Where:

t = time in seconds of one time constant
L = inductance in henries
R = resistance in ohms.

Once this simple formula is calculated for a given circuit, the length of time (t) is used to relabel the bottom of the generic graph above and it is possible to determine from that specific graph what percentage of the full eventual expected current would be flowing in the circuit at any given instant in time. In addition, Ohm's Law would be solved for the expected current (I = V/R, current = voltage/resistance), and the left edge of the graph relabeled so that the graph can be used to determine the instantaneous current at any moment in time. It is relatively easy to get high school students to understand this concept and how to solve problems using this methodology--it is quite practical and the application is easily seen. These methods are more fully explained and illustrated in a paper and textbook by Haynie (1986B and 1986A respectively) and have been used successfully for over 25 years in teaching electronics.

The alternate "engineering school model" of explaining this relationship between time and current is through the function, $I = f(t) = \frac{V}{R}(1 - e^{-\frac{Rt}{L}})$ where I is current, t is time in seconds, V is voltage, R is resistance, and L is inductance. This function can be evaluated at any instant of time to find current. In any specific problem, once the values of V, R, and L are established, they become constants in the formula for that problem. Even "e" is simply a constant value approximately equal to 2.718, similar to the more familiar π of about 3.14. Thus, the only variable is t (time in seconds). The instantaneous current for any point in time may be found by inserting the time into the formula and solving for I (current). Teachers using this method assume a strong background in mathematics (at least Algebra II) and expect the formula to facilitate the understanding. Yet there is no guarantee that the students have any conceptual understanding of the relationship. The time constant approach expected little mathematical background making it appropriate for most secondary school electronics students. Although it built the concept, it never brought the students to the math formula. To finish the time constants lesson in a way that fully incorporates the "concepts to math approach", the lesson should end with the students being given the function that explains the relationship and applying it to new problems. With the availability of the graphics calculator, beginning secondary students can be taught to understand and use the formula, draw the graph on the calculator, and fully integrate their understanding.

Mathematics teachers have often used this function for current abstractly as an example of an exponential function. It is a variation of the basic function, $f(x) = a^x$, where $a = e^{-\frac{R}{L}}$ and $x = t$. In the recent past, the mathematics approach has been similar to the "engineering school model" of expecting the students to gain understanding through the formula. The present reform movement in calculus would mandate another approach. To the reformers, the better approach would more nearly model the "concepts to math approach". Students would be given examples of real or hypothesized data, they would be shown how to organize the information into data points which lead to the development of a graph and knowledge of the concepts and principles under study, and then they would use this information to develop the appropriate formula/algorithm/approach to model the problem. After a few problems have been approached this way, the teacher can help students see the pattern which is developing and how the more abstract, generalized form may be applied in several different settings (Hughes-Hallet, Gleason, et al., 1994).

The present electronics example could be used in this way. Let L = 20 henries and R = 10 ohms. The length of a time constant would then be 2 seconds. The table below shows some data points.

TIME IN SECONDS	% OF CURRENT (I)	REMAINING % OF CURRENT BEFORE MAXIMUM (100%)
2	63.21	36.79
4	86.47	13.53
6	95.02	4.98
8	98.17	1.83
10	99.32	0.67

The last column in the table is the distance from the asymptote for each point in time. Note that, if we divide each value in this column by the preceeding one, we have a constant ratio: $\frac{13.53}{36.79} = \frac{4.98}{13.53} = \frac{1.83}{4.98} = \frac{0.67}{1.83} = 0.37$. When students see a table containing constant ratios for equally spaced t values they should recognize that an exponential function will model that data just as a linear function models data with a constant slope (Hughes-Hallet, Gleason, et.al., 1994, p.20).

Exponential functions also describe compound interest determination, radioactive decay, population growth, and many other types of growth or decay in our real world. When students realize that they can predict outcomes or even steps along the way in these settings via such a simple method, they then have truly achieved fluency in this portion of the language of mathematics, and they will have acquired important tools for application in broader study in any discipline which uses this function. This learning should be appropriately reinforced and utilized in the study of economics, social studies, sciences, and in other settings. Coordinating the efforts of the mathematics teachers with the disciplines using this concept will bring students to much greater appreciation of the modeling capabilities of mathematics.

The Main Point: A Summary

All teachers must consider how the subjects that they teach relate to one another and how each uses, depends upon, and builds upon all of the other disciplines taught in the schools. The one room schoolhouse had many problems: teachers were overburdened, students varied greatly in age and readiness, the same teacher taught everything whether they knew it well or not, and it was probably impossible for the curriculum to be well organized. Still, it had one big advantage over today's mega-schools--the teacher knew when students were studying the same thing in three different subjects simultaneously (Haynie, 1985). With just a little prior planning and communication, we can recapture that advantage for today's students. Movements such as the Paideia curriculum in communications and social studies are a reflection that some teachers are beginning to see the importance of helping students see the relationships among topics and disciplines so that each may be learned more fully and in a broad context. Certainly proponents of the STS movement must agree with this viewpoint. As a fundamental language of technology, mathematics can serve as an important interdisciplinary bridge in the school curriculum. Teachers in all disciplines need to communicate with each other and search for opportunities to integrate the curriculum, especially teachers of mathematics, science, and technology.

References

Haynie, W. J. (1985). The basics: Is your laboratory a battleground in the fight against ignorance? The Technology Teacher, May/June, 6-9.

Haynie, W. J. (1986A). Electricity and Electronics Today. Saint Paul, MN: EMC Publishing.

Haynie, W. J. (1986B). Mathematics: The misunderstood language of high technology. In Sanders, M. E. (Ed.) Technological Literacy: An Educational Mandate, Proceedings of Technology Education Symposium VIII, Virginia Polytechnic Institute & State University, Blacksburg, VA, pp. 29-32.

Hughes-Hallet, D., Gleason, A. M., et.al. (1994). Calculus. New York: John Wiley & Sons, Inc.

National Council of Teachers of Mathematics (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

Steen, L. A. (Ed.). (1994). For all practical purposes.(3rd ed.). New York: W.H. Freeman and Co.

Tannenbaum, P. & Arnold, R. (1992). Excursions in modern mathematics: New Jersey: Prentice Hall.

WOMEN AND GENES: FINDING THE RIGHT FIT

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Physicians have always used potions, chemicals and changes in surroundings to heal patients. In the past, a patient may have sipped herbal teas, swallowed chemical tablets or breathed fresh air. Yet recent advances in medicine and biology such as identifying individual human genes and altering them, may take the place of some of these older methods. Genes, sometimes referred to as the building blocks of human life, are found in cells and largely determine what the body looks like, how it works and how it reproduces itself.[1] Physicians can now identify selected specific genes, such as one that may lead to breast cancer, and in the future may be able to fix a gene directly instead of treating the etiologic manifestation within the entire body. Many physicians now believe that curing a sick patient in the future may be as easy as changing the patient's genes, thus the medical term, gene therapy.

Although the tools used to manipulate genes are elaborate and technical in design (e.g., vectors for insertion or micro-injection techniques), understanding, or picturing the end result, does not require 'extensive scientific knowledge' or 'sound ethical reasoning'. The rhetoric and professional insulation that surrounds gene therapy, however, is immense, justifying the belief that gene therapy is complex and control of the technology should fall into the hands of scientists, physicians or other responsible social elites. This paper asserts that if gene therapy is assumed by the common woman as too complex to understand she may not participate in genetic debates and ultimately may reduce or lose her ability to voice concerns over the use of gene therapy. In essence, women may lose their autonomy in the physician-patient relationship--one more medical casualty in the advancement of science. In this paper I use the term 'autonomy' to refer to the ability of the individual to act on behalf of the individual. This entails using one's own voice and recognizing varying alternatives to decisions. Not unlike informed consent, one can argue that complete individual autonomy in a relationship is unattainable; however, I will use this term as it is a worthy goal and of particular interest in feminist theory and bioethics. To better ensure that women are not left out of this debate, I will give a brief description of two forms of genetic therapy, somatic cell therapy which affects the individual patient, and germ-line therapy, which affects the babies of the patient. I will argue that a loss of autonomy may accompany germ-line therapy. Then I will offer prescriptions for reducing a loss of autonomy.

There are a number of complex ways to look at how therapy affects genes. There are also some simpler ways to consider how therapy affects the patient. Instead of concentrating on the cells, it is wise to concentrate on the patient and what happens to the patient after the therapy. For example, a woman may know that her mother carries a particular deleterious gene which we can call 'gene A'. Because her mother has it, there is a chance that she will have it as well. Since she realizes that she is at risk for transmitting the gene to her children (should she have it), she goes to a specialist to have that physician look at her genes. The specialist studies the patient's genes and discovers that she is carrying the 'bad' gene. The physician uses therapeutic methods to change the gene, after which, she will not 'come down' with disease A--'she is effectively cured'.[2] At first glance, this seems to be a wonderful procedure--the woman was going to get a disease and the physician fixed it so that she would not. Unfortunately, not all cases of gene therapy are this straight forward. The consequences of gene therapy differ based upon which kind of cell is being fixed. It is important that women realize how the question of autonomy alters from one kind of therapy to the next; therefore, a short description of both somatic cell and germ-line therapy follows.

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[1] It is important to note that genes, as well as the body itself, cannot be separated from their environment. Depending upon the specific trait identified, both genetic factors and environmental factors play a part in creating a final organic product.

In the above case, the woman who carried the A gene went through somatic cell therapy. The treatment did not affect her eggs or embryo. All human cells are somatic unless they are used for reproduction. Somatic cell therapy only affects the person undergoing therapy. Patients enter treatment of their own will and the physician concentrates on altering one particular type of cell. Described in this way, there seems to be little difference between using somatic cell therapy for blood or penicillin for an infection. In fact, one may argue that there is no real difference and that as long as we accept medical interventions such as dialysis, pacemakers, and penicillin we should likewise accept somatic cell therapy, because all that is affected is the consenting patient who retains individual autonomy in the physician-patient relationship. Because it is relatively benign, that is, it has no real long-term effects--somatic cell therapy is generally accepted and according to Munson (1992) most believe that "somatic-cell therapy in humans is likely to become an established form of treatment within the next two to five years" (p. 407). However, germ-line therapy is not nearly so benign.

Germ-line therapy not only affects the patient, but the patient's future children. Because germ-line therapy uses the patient's eggs or sperm, the alterations will affect the patient's heirs. Take the case of the woman with disease A. The woman realizes that she carries the gene which leads to the disease, but wants to keep her future child safe from the disease as well. Unfortunately, her egg carries the gene. Hypothetically, the physician could offer to alter the egg and remove the gene. An egg which is then fertilized leads to an embryo that does not carry the gene and a child who will neither have nor carry the gene. Potentially, there are multiple diseases or characteristics that physicians can alter. Clearly the ethical, social and moral stakes are increased when one chooses to support germ-line therapy as opposed to somatic cell therapy.[3] When individuals speak of the future and the power of genetics to wipe out birth defects, they are generally speaking of germ-line therapy. According to Munson (1992): "Most of the moral issues discussed in connection with gene therapy have centered around germ-line therapy. It holds out the prospect of genetically engineering sex cells to produce offspring with virtually any set of characteristics desired" (p. 407). This future person will never have the chance to decide if it wants to be altered. That person's autonomy, or ability to decide for itself, was knowingly diminished by its mother. Because the mother knowingly reduced the autonomy of her child, people may wonder if the same woman's claim of wanting to express her own autonomy is a shallow claim. If autonomy in the physician-patient relationship was important, she would not reduce the future autonomy of a future patient.

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[2] It is important to note that this example refers to a dominant trait. Some diseases require that certain 'bad' genes be passed on by both the mother and father before the child will exhibit the disease. Thus there is a difference between being a carrier of a gene (having the gene but not the outward appearance of a disease) and actually exhibiting the disease.

[3] Because of the ethical dilemmas that germ-line manipulations present, current NIH guidelines for federal funding of pre-implantation (in vitro) human embryo experimentation do not allow germ-line manipulations.

Although germ-line therapies are unusual, they can be justified based upon the economic and emotional savings to the family. One who supports the use of germ-line therapy, may use the economic argument that it is cheaper to fix a problem once than to offer multiple treatments to multiple patients--including the babies of patients. No 'rational' person would choose to live with a disease such as Cystic Fibrosis as the emotional, physical, and financial strain on the patient or family is immense. If we assume that all Cystic Fibrosis patients will opt for genetic therapy--why bother with recurrent somatic cell therapies? The problem is that the physician and patients may not know where to draw the line with genetic therapy. Mary Carrington Coutts (1994) clearly states this predicament:

> Many persons who voice concerns about...therapy...use a 'slippery slope' argument. They wonder whether we will be able to distinguish between 'good' and 'bad' uses of the gene modification techniques and whether the potential for very harmful abuse of the technology should keep us from developing the techniques (Hubbard and Wald 1993, p. 116). (p. 68)

I agree that these technologies may be used for a number of alterations--some of which may be less acceptable than others; however, the most important problem is that the use of this technology, regardless of the trait altered, inherently removes the future autonomy of patients by reducing their choices in a physician-patient relationship. Present day society may believe that this is an acceptable trade-off, yet we must question who is making this decision on behalf of 'society' and what parts of society are harmed by this decision before women begin undergoing gene therapy.

Reproductive choice in feminist theory concentrates on the role of the woman and physician, at times reaching into the realm of the woman, the fetus and the physician. In these classic cases the parties are readily identifiable, and autonomy or lack there of, is relatively easy to identify. The question which should keep women up at night is, where is the accountability of the physician 70 years later? The female patient who exercises her autonomy while accepting germ-line therapy cannot be certain that her future generations will have that same autonomy. If women undergo germ-line genetic therapy, they will inevitably remove decision-making power from future patients.

Medical sociologists have considered the physician-patient relationship and feminists have considered reproductive rights and female autonomy. These questions have centered on the dialogue and role of the female patient and physicians. Unfortunately, the physician-patient relationship debate, while useful in understanding the implications of somatic cell therapy, is lacking in germ-line therapy. The reason that these arguments are not complete is that germ-line therapies have at least two patients: the woman and the future child. Although the woman is in the position to act on her own behalf, it would be paternalistic for her to assume that she is a legitimate voice for the countless generations that will follow her. The woman has autonomy. Some would say that the future child does as well. However, these future patients will not have the option to express their medical desires, nor may they have the option to alter back to the previously desired state from generations before. The autonomy of women's daughters and sons is dismissed by one shortsighted generation.

In other words, this is not the same argument seen in abortion politics where the autonomy of the child is already assumed--it is instead an argument which focuses on the lack of future autonomy of a person. A question of autonomy does not hinge on the fetus having any special moral rights such as a right-to-life; rather the argument rests on the belief that one day human beings will in affect be denied autonomy to decide for themselves what traits they want altered and what traits they do not. A simplified version of abortion politics would demonstrate that the embryo is a person. With this status the baby should be protected from harm. The autonomy argument asserts that the embryo will eventually develop into a being that one day will be a person. This status may come at conception, eight days, two years or twenty years--but it will come. At this point, the being will not have the option to decide for itself to undergo therapy, the decision will have already been made for it. Women who have struggled to express autonomy in the physician-patient relationship must now consider if reducing even more human autonomy is wise. If autonomy is an important feminist concept, women should take care when dismissing the future autonomy of even hypothetical actors. In effect women may inadvertently delegitamize their own claims by dismissing the autonomy of non-persons who one day will be persons.

If germ-line therapy weakens autonomy, we must ask ourselves how can we combat it? I present three areas which require our attention and consideration. First, women must identify who is behind genetic manipulation technology and what the technology represents; second, women should identify who is affected by the technology and third, women should find a forum in which these considerations can be voiced and discussed among concerned parties. Discussing these three points does not require scientific or ethical expertise, but life experience. If women proceed cautiously and with their eyes open, there is no reason that any woman, regardless of her experience or education should not enter into these discussions and in so doing, better prepare herself for the future.

First, women must seek to limit or eradicate technology which hides the relationship between the physician and the patient. This would entail identifying what the technology does, who creates it and who perpetuates its legitimate use. This is a concept that is widely accepted in the academy as well as the reality of day to day living. If women wish to question genetic manipulations, they must question the tools used to achieve the manipulations. The technology is political (Winner, 1986). It settles questions of power and can represent power structures. Studying the use of the tools, regardless of their complexity, will lead women to the actor(s) who designed them. Once women begin to follow the actors, they may better identify what is encased within some of these relationships and what it may mean for the future of women's autonomy in the medical establishment. Questions to consider include can women use the technologies outside of the medical establishment therefore returning the autonomy to themselves by co-opting these technologies with their own terms and meaning (Haraway, 1991)? Secondary to this question of political artifacts is identifying the actors using the tool. Who are these people? How do they stay in business and who funds them? What are the larger social structures and arenas in which these actors move and how safe is it for women to enter into a relationship with these actors, particularly where questions of autonomy are addressed?

In addition to identifying the politics associated with the technologies and techniques, women should next identify who is affected by the technologies. As noted in this paper, depending upon the kind of therapy, the actors may be more than previously thought. In this regard women should realize who the actors are and identify if they can express their present or future autonomy. If they are incapable, then women must come to some understanding and acceptance of how to consider the rights of this non-present actor (the embryo who one day will be a person) and whether or not they should be able to express or remove that actor's future autonomy. Germ-line therapy assumes that the embryo is altered for its own good. How can society assume this, and if society makes this assumption who is the one or who are the ones to accept responsibility for this decision?

A third and final recommendation to the woman who wishes to consider gene therapy and issues of autonomy is to create a niche for discussion within a forum already attuned to the complexities of women's autonomy in the face of professional, scientific, or technological considerations. The field and literature of feminist theory offers fertile ground for debate and consideration of this highly technical endeavor as it considers autonomy and the social role of women in the medical establishment. Yet this discussion should not exclude the so-called lay-woman. Reasonable discussion of gene therapy does not require a background in genetics, biology, or feminist theory. I have argued that women need not be fully aware of the mechanics or method to assess the impact of gene therapy and participate in debates over it.

Ultimately, I argue that autonomy in genetic therapy has a shaky future. Women have fought many battles to gain the autonomy and voice that are currently at the disposal of any woman who enters a physicians office. Urgings of "Talk to your doctor" are now common and it is with this background that I urge women to consider where the autonomy is located in gene therapy.

Somatic cell therapy is different from germ-line therapy. As such it is helpful and necessary for women to be clear in the distinguishing characteristics. Although partial knowledge of a technique or subject is generally less desirable than complete knowledge (whatever that may be), women should consider the basic differences which separate and distinguish gene therapy as it is their autonomy that is at question. The basic premise and ethical considerations which surround gene therapy are not difficult to grasp and should be common knowledge. Somatic cell therapy may well be analogous to dialysis, but germ-line therapy is not. In this second consideration, it is clear that the question of autonomy does not merely apply to the woman, but it extends to her children as well. Women stand to gain and to lose, the question is how do the different forms of therapy affect autonomy and more important, how can we assure women of all backgrounds and educational levels that understanding the questions which surround gene therapy are not beyond their grasp? Once women realize that the implications of gene therapy are not too difficult to understand, they may be more comfortable expressing their feelings and beliefs over its use. Further, by voicing their concerns and goals, women may also demonstrate the need for protecting the individual patient's autonomy to ensure more fair and appropriate medical care.

References

Coutts, M. C. (1994). Human gene therapy. Kennedy Institute of Ethics Journal, 4 (1), 63-83.

Haraway, D.J. (1991). Simians, cyborgs and women: The reinvention of nature. London: Free Association.

Munson, R. (Ed.) (1992). Intervention and reflection: Basic issues in medical ethics (4th ed.). Belmont, CA.: Wadsworth Publishing Co.

Winner, L. (1986). The whale and the reactor: A search for limits in the age of high technology. Chicago: University of Chicago Press.

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Community or Commodity?

– Reconsidering the Environmental Movements in Taiwan

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In the post-industrial era, markets and technology are increasingly considered as appropriate and necessary substitutes for political choice. It is argued by post-industrial enthusiasts that the role and scope of public policy needs to be narrowed to those initiatives that facilitate a post-industrial reality of markets and technology. In this "reality," the fate of local communities, especially in urban areas, is determined by their exchange value (i.e., their capacity to promote economic activity), rather than their social value as places of shared activities and commitments. A local community is largely reduced to a commodity in the economic game and can be sacrificed to achieve higher economic growth.

However, this reductionist treatment of local communities is being challenged worldwide. A particularly potent challenge is being mounted in the form of environmental protests. Movements are demanding that communities not be treated as dumping grounds for the wastes and pollution of post-industrialism. In reaction, post-industrialists charge environmental protests with selfish NIMBY (not in my backyard) or LULU (locally unwanted land uses) motivations. It is asserted that if local communities are permitted to exclude unwanted facilities, larger societal benefits will be lost.

In this paper, we argue that NIMBY and LULU are more properly conceived as expressions of conflict between community and capital and between community and state. This paper explores this argument in the concept of the emergence of environmental movements in Taiwan. Particular attention is paid to the capital-state relationship.

Petrochemical Industry in Taiwan

Taiwan is famous for its economic development. The petrochemical industry has played an important role in the achievement of the country's "economic miracle." It contributes 20 to 30 percent of Taiwan's GNP. Chang Kwang-shih, former Vice Minister of Economic Affairs, has stated that "the petrochemical industry is of the utmost importance to the continued economic growth in Taiwan" (1977, 4).

The industry has become a major sector in state economic planning since the 1960s. The government is not only the major promoter for this industry, but also the single owner for all five naphtha cracking plants in Taiwan, which produce the major feedstock for the petrochemical industry. These plants are the key components of two petrochemical complexes—Linyuan and Tasheh.

Most of the middle stream of the petrochemical plants in Taiwan are entirely or partially owned by the state and the ruling party-KMT. Chang (1977) points out:

> [T]he largest single investment in the petrochemical industry is from government funds. State-owned petrochemical enterprises are involved primarily in the production of basic petrochemicals, such as products from naphtha crackers, aromatic processing units and ammonia plants. (3)

In addition, the state- and KMT-operated plants produce petrochemical intermediates for downstream manufacturers. Chang observes that, "the government has also participated as a minority shareholder in joint ventures with local private and foreign investors" (1977, 3).

The state controls oil imports to Taiwan, therefore, it was able to take full advantage of its position as the single owner of all naphtha cracking plants. Because petroleum is an essential raw material for economic development, the government intended to control all upstream petrochemical production. But the state not only dominated the upstream petrochemical production, it also intervened in the production of petrochemical intermediates. The state and KMT invested in several major intermediary corporations and earned a great amount of benefits (Cheng 1991; Lin 1989).

Since the Taiwan state has been controlled by the KMT from the outset, there can be little doubt of whose interests were served by these arrangements. Indeed, the matter was taken for granted, as evidenced by the fact that the board directors or general managers in Chinese Petroleum Corporation (CPC) were routinely transferred to equivalent positions in the petrochemical intermediary corporations after their retirement from CPC. The very close relations between CPC and major intermediary corporations is further evidenced by the fact that the leaders of CPC were always former followers of the chairmen of the intermediary corporations. Hence, the petrochemical policies crafted by CPC benefitted, by design, the intermediary corporations (Lin 1989, 178-81).

However, the petrochemical industry has become one of the few fully integrated industries in Taiwan. It supplies the basic raw materials for two of Taiwan's important industries—plastics and synthetic fiber. Petrochemical output could not only be used in the production of clothing, building materials and other daily consumer goods, it also could be exported as a variety of industrial products. Thus, by 1988, 24.1 percent of total manufacturing production in Taiwan came from this industry. This industry also contributed 21.8 percent of total exports. There were approximately 669,000 people employed by the petrochemical sector, which amounted to 23.5 percent of total manufacturing employees in Taiwan. This was why Premier Hau Pei-tsun asserted "the petrochemical industry [was] related to the continued economic growth in Taiwan," and insisted on the construction of the fifth naphtha cracker, which was severely objected by the local community (The United News 1990, September 15).

However, petrochemical industry operations have been linked to serious air, water and noise pollution in Kaohsiung region. Measurements of pollution from these plants indicate that they are at high enough levels to cause harm to human health. Since the late 1980s, numerous environmental protests have taken place within the communities which surround the naphtha cracking plants and the two petrochemical complexes.

Metropolitan of Kaohsiung

Taiwan's petrochemical industry is almost entirely concentrated in the metropolitan of Kaohsiung where a natural harbor offers the benefits of import and export of materials and goods essential to the industry's growth. Kaohsiung, which includes Kaohsiung municipality (KM) and Kaohsiung prefecture (KP), was designed by the state as a major industrial area in the early 1950s. Kaohsiung is presently the largest metropolitan in southern Taiwan and Taiwan's major industrial area due to the state's industrial and spatial policies. The refineries of the Chinese Petroleum Corporation (CPC), which is the country's only petroleum corporation and is owned by the government, were rebuilt here in the 1950s. In the early 1970s, a large number of government-owned, capital-intensive industries were established in this area. One of them was the CPC petrochemical complex, including both upstream naphtha cracking facilities and downstream petrochemical production.

With Taiwan's rapid industrialization in the 1970s, Kaohsiung has become the most polluted area in Taiwan (Hsiao 1987, 30). In terms of air pollution, Kaohsiung has had total suspended particulate (TSP) concentrations above the national standard of 130 ug/m^3 since monitoring was begun in 1979. The amount of particulate with diameters of less than 10 microns (PM10) has also been higher than the national standard of 65 ug/m^3. The TSP and PM10 levels in Kaohsiung prefecture have also been above the healthy air standards set by the country.

Between 1979 and 1990, the concentrations of sulfur dioxide (SO_2) in Kaohsiung municipality were continuously higher than 0.03 ppm, the national standard. In 1991-2, SO_2 levels fell just below the 0.03 standard.

The situation in Kaohsiung prefecture was very similar to the municipality. These air pollutants are harmful to human health.

Ozone, another serious air pollutant, also has been at elevated levels in the Kaohsiung municipality since air quality monitoring began. According to Taiwan's EPA (1992b, 105-6), the metropolitan of Kaohsiung is seriously polluted by ozone, with 1094 times in 1990 that ozone levels were higher than the national eight-hour standard.

The metropolitan of Kaohsiung has had very serious noise pollution because of the many heavy industries located in or around residential areas. In 1990, there were 1,744 citizens' petitions in the Kaohsiung municipality alleging noise violations. The number of complaints in Kaohsiung prefecture was 562 in the same year (EPA 1992b, 121-6).

The Kaohsiung metropolitan area has endured a water pollution crisis, as well. The Houchin river, which flows through the northern region of Kaohsiung, is filled with industrial wastewater. A large number of industrial factories are located along this river and directly dump their untreated wastewater into it. Unbelievably, the figure of DO (dissolved oxygen) in Houchin river is zero (CPC 1988, 4-54). According to national standards, DO's levels under 2.0 mg/l is classified as a very serious condition. In addition, a BOD (biochemical oxygen demand) figure above 15 mg/l is classified as a very serious condition, but the BOD figure in Houchin river is 600 mg/l. The pollution in the Houchin river reached alarming levels causing the EPA to announce a special regulatory plan in 1990 to deal with the river's pollution problems. However, according to EPA's plan, the DO in Houchin river will not reach 2.0 mg/l (the standard that represents a very serious condition) until 1998 (EPA 1992b, 149).

The Kaoping river, the largest river in the Kaohsiung area, also has been seriously damaged by wastes coming from the petrochemical complex (as well as other sources, for example, pig raising plants). The river flows through the southern port of the metropolitan area, and supplies approximately half of the drinking water for Kaohsiung. Pollution in this river is a danger to human health for the citizens who live in this area. For this reason, most of Kaohsiung's citizens dare not drink tap water, buying spring water instead.

The coastal waters around the metropolitan of Kaohsiung are also polluted, both because of the filth flowing from the Houchin and Kaoping rivers and the direct discharge of wastewater from the industrial estates. The river mouths of the Houchin and Kaoping rivers are seriously polluted, with measurements of BOD and heavy metals registering much higher levels than accepted health standards allow (EPA 1992b, 157; 1992a, 356-8). In addition to river-borne pollution, there are two direct transmission pipelines from the petrochemical complex that release industrial wastewater into the Taiwan Strait. One is located in northern Kaohsiung to discharge wastewater from the Kaohsiung Refinery Plant (KRP), Jenwu, and Tasheh petrochemical complexes. The other one is situated in southern Kaohsiung and discharges wastewater from the Linyuan petrochemical complex and the Taliao and Linhai industrial estates. None of the industrial wastewater is well treated. The coastal waters around the metropolitan area of Kaohsiung are so badly polluted with heavy metals that fish taken from these waters may not be fit for human consumption. The threat to the coastal ecology of the metropolitan area of Kaohsiung has brought complaints from fishermen who claim that their catch in these waters has decreased in recent years.

Three Cases of Environmental Protest

Among the five naphtha cracking plants, the first, second and fifth are parts of the Kaohsiung Refinery Plant (KRP) owned by CPC. In 1987, angry residents of Houchin village lodged strong protests against the state's plan to build a new large naphtha cracking facility inside the KRP. The protesters declared they would resist the plant's construction in an effort to stop more pollution in a region that had suffered for more than four decades from pollution coming from the KRP. The protest continued for three years. Finally, the government agreed to pay monetary compensation to the residents, to improve its environmental pollution control, and to move out all refinery and petrochemical plants in the following twenty-five years.

In 1988, the Linyuan complex which contains Taiwan's third and fourth naphtha cracking plants was shut down by angry residents for four days. Protesters near the complex forced the closure following a breakdown in negotiations over pollution from the complex's water-treatment plant. Because the complex is the largest petrochemical compound in Taiwan, the government quickly tried to solve this impasse. A costly settlement finally was reached through emergency talks among residents, companies and the Ministry of Economic Affairs' Industrial Development Bureau (IDB). Twenty-one districts in the Linyuan area received a total of US$ 50.8 million in compensation from the companies in the complex, and the companies have a year to modify the water-treatment plant.

In May 1993, the Tasheh petrochemical complex was forced to close because of its air and water pollution. Angry residents living in this community demanded that all petrochemical plants move out of their region within the following ten years. The reaction coming from the government was the same with the Linyuan case. The chief of IDB and the Economic Minister tried to negotiate with the community and asked plants located in the Tasheh complex to supply compensation.

Importantly, these protests employed tactics of collective action rarely seen in Taiwan. Residents used force to block operation of the petrochemical complexes and refineries, and tried to shut them down. Violent conflicts between citizens and police were common in three demonstrations. Why did protesters resort to disruption of such powerful institutions as the CPC and the state authorities to express their grievances? The reason was that the protesters had been systematically excluded from the political structure and institutional disruption became the only way for them to express their discontent. There is also the civilization of the national government that preceded these protests and which set the stage for political challenges to the status quo.

For the state, these protests raised important problems of control and threatened the ability of the state to commit the society to economic growth without regard to the cost. Thus, to dissolve the environmental protests, the government insisted that the environmental pollution from the petrochemical complexes could be controlled by newly developed technologies, and attacked the environmental movement for irrational behavior in rejecting economic progress based on scientific and technological achievements. According to the state, the most important thing the polluted communities needed to do was to accept the new technologies. When this tactic failed, the government sought to buy support for its overall program by offering to compensate the victims.

What is the Problem? Community or Commodity?

Furthermore, the government in Taiwan has defined the problem of environmental pollution as a location problem. It believes that the relocation of the petrochemical industries is one of the best ways to resolve community anger. For example, one governmental administrator indicated in an interview that "the basic way to solve the environmental disputes . . . is to move the factories in Linyuan and Tasheh to a place of low population density. The place must be separated from populations of any size."[1] The Minister of EPA, Chang Lung-sheng, also indicated that the relocation of the polluted industries was the appropriate strategy to solve the problem of environmental protests (1993, 10).

Basic assumptions underlying the relocation argument include: 1) petrochemical industries will, and must be allowed to, continue to generate hazardous waste; and 2) petrochemical industries will, and should, continue to externalize the costs of hazardous waste disposal and treatment (Lake and Disch 1992, 667-9). Undoubtedly, the new site will be polluted after the relocation of those petrochemical industries. But if very few people live there, so the reasoning of the government goes, there should not be the same level of environmental protest as the industries face now.

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[1] The interview was done in May 1994 when the first author did his field study in Taiwan.

But this fundamentally miscasts the problem. The processes of commodity production and exchange are basic components of the capitalist system. The state depends upon capital accumulation through commodity production and, for this reason, must stand ready to help capital accumulation through its intervention. As Claus Offe puts it "state actors must be interested—for the sake of their own power—in guaranteeing and safeguarding a 'healthy' accumulation process" (1984, 120). Thus, capitalist enterprise and the state are jointly bound to try to impose commodity and exchange relations on local communities and individual citizens. As Offe (1984) argues, the structure of the capitalist state becomes problematic if "economic units of value fail to operate in the commodity form" (1984, 121). He further points out that:

> The link between the political and the economic substructures of capitalist society is the commodity form; the stability of both substructures depends upon the universalization of this form. (121)

To preserve its power, the capitalist state intervenes in order to facilitate the transformation of social activities into commodities. The capitalist state's policy is termed by Offe as "recommodification." In this policy, the fate of local communities, especially in urban areas, is to be determined by their exchange value (i.e., their capacity to promote economic activity), rather than their social value as places of shared activities and commitments. A local community is largely reduced to a commodity in the economic game and can be sacrificed to achieve higher economic growth. Lewis Mumford (1934) warned us of the problem.

> In this [industrial] world the realities were money, prices, capital, share: the environment itself, like most of human existence, was treated as an abstraction. Air and sunlight, because of their deplorable lack of value in exchange, had no reality at all . . . the reek of coal was the very incense of the new industrialism. A clear sky in an industrial district was the sign of a strike or a lock-out or an industrial depression. (168-9)

However, this reductionist treatment of local communities is precisely what was challenged in Houchin, Linyuan and Tasheh. These movements demanded that their communities not be treated as dumping grounds for the wastes and pollution of industrialism. In reaction, the state and its corporate allies charged that environmental protests were selfish NIMBY (not in my backyard) or LULU (locally unwanted land uses) responses. They asserted that if local communities are permitted to exclude unwanted facilities, larger societal benefits will be lost.

However, as Lake and Disch (1992) have pointed out, NIMBY and LULU are more properly conceived as expressions of conflict between community and capital and between community and state.

> The basic assumptions of hazardous waste regulation define the hazardous waste problem as a *locational* problem for the state rather than a *production* problem for industry. This transformation enforces the externalization of wastes from the production process, translates an economic problem for capital into a political problem for the state, and insulates capital from the negative consequences of accumulation. (671)

Lake further argues that "facility siting constitutes a state political-administrative response to economic crisis that minimizes the costs to capital and concentrates costs on communities" (1993, 88). The hazardous waste production problem is transformed into a siting issue. This strategy "serves to deflect political conflict away from a potentially daunting challenge to the state-capital relation and into a debate over location" (Lake and Disch 1992, 665).

Conclusion

The state in Taiwan has tried to divert attention from the problems of production or capital accumulation of the industries to the problems of location and technology. Under Taiwan's rapid industrial growth strategy, environmental pollution is being treated as though it is a "normal" risk of development. Greater importance is given to expanded production capacity and technological innovation, while political and social values, such as equity, environmental balance and governance are all marginalized. The challenge of environmental movements on a societal scale is to resist the paradigm of "normal" pollution (Byrne, Hoffman and Martinez 1989) and to assert the values and aims of communities over those of commodity production and capital accumulation (Castells 1983).

REFERENCES

Byrne, John, Steven M. Hoffman, and Cecilia Martinez. 1989. Technological politics in the nuclear age. Bulletin of Science, Technology and Society 8:580-94.

Castells, Maneul. 1983. The city and the grassroots: A cross-cultural theory of urban social movements. Berkeley, CA: University of California Press.

Chang, Kwang-shih. 1977. Development of petrochemical industries in the Republic of China. Industry of Free China 47 (February):2-8.

Chang, Lung-sheng. 1993. Chung ta kung hai chiu fen shih chien chih tan tao yu yin ying tse lueh. (To explore the reasons for the emergence of those seriously public nuisance disputes and to inquire the strategies to solve them). Industry of Free China 78(12):5-10.

Cheng, Shih-Meng S. and et al. 1991. Chieh kou tang kuo tsu pen chu i (Disintegrating KMT-state capitalism: A closer look at privatizing Taiwan's state- and party-owned enterprises). Taipei, Taiwan: The Cultural Department of the Independent Evening News.

Chinese Petroleum Corporation (CPC). 1988. Ti wu ching yu lieh chieh kung chang chi hua huan ching ying hsiang ping ku pao kao (pen wen). (The report of environmental impact assessment of the fifth naphtha cracker (main body of writing)). Taipei, Taiwan.

Environmental Protection Administration (EPA). 1992a. Chung hua min kuo tai wan ti chu ti feng huan ching tsu hsun. (Local environmental information for the Republic of China in Taiwan 1991). Taipei, Taiwan.

———. 1992b. Huan ching pao hu nien chien. (The environmental protection yearbook 1990). Taipei, Taiwan.

Hsiao, H. H. Michael. 1987. Wo men che you ye keh tai wan. (We only have one Taiwan). Taipei, Taiwan: Yuan Sheng Publishing Company.

Lake, Robert W. 1993. Rethinking NIMBY. Journal of the American Planning Association, 59:87-93.

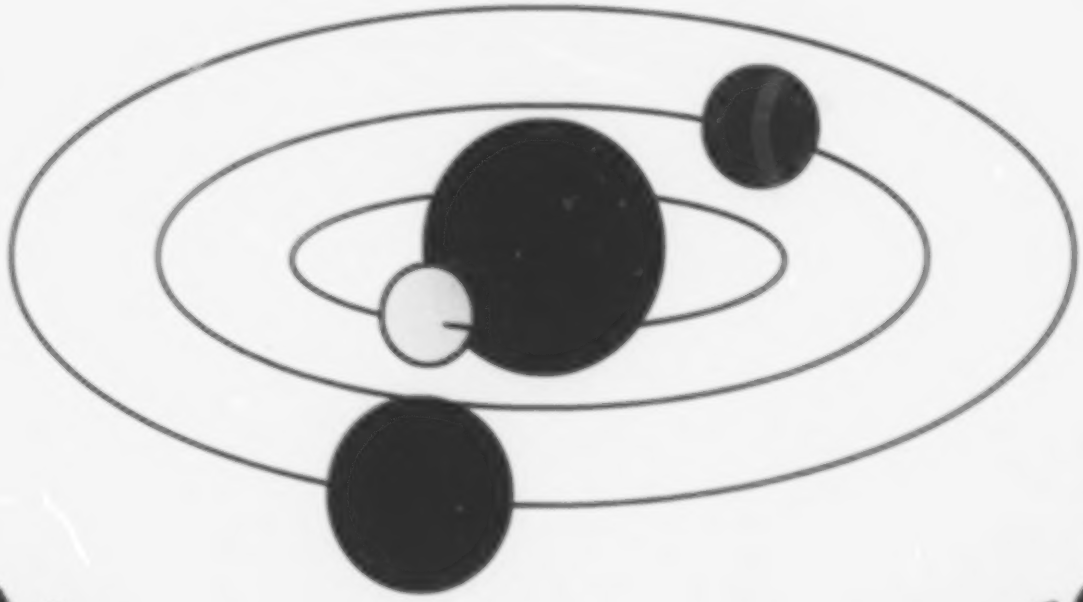
Lake, Robert W. and L. Disch. 1992. Structural constraints and pluralist contradictions in hazardous waste regulation. Environment and Planning A, 24:663-81.

Lin, Tsai-hui. 1989. Chung yu yu shih hua yeh chan chan pu hsiu—Shih hua yeh yu chung yu kuan hsi che pu ching. (A continuing fighting between the Chinese Petroleum Corporation and the petrochemical industries—A closed relation between the Chinese Petroleum Corporation and the petrochemical industries). Tsai Hsun (The Wealth Magazine) 9:178-81.

Mumford, Lewis. 1934. Technics and civilization. New York: Harcourt Brace Jovanovich, Inc.

Offe, Claus. 1984. Contradictions of the welfare state. ed. John Keane. Cambridge, MA: The MIT Press.

SCIENCE, TECHNOLOGY AND SOCIETY



COLLEGIATE PROGRAMS

TEACHING INFORMATION SELF-SUFFICIENCY IN THE ACADEMIC DISCIPLINES:
A THREE-TIERED APPROACH

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In this age of limited resources, both the skyrocketing costs of information and the exponential acceleration of research in the sciences and social sciences make it increasingly difficult to meet the specialized information needs of the academic teaching and research community. In Science in the National Interest, Bill Clinton acknowledges the necessity for continued support of the sciences, and he issues a nation-wide call for "Technological Literacy." We at Penrose Library, at the University of Denver, have been answering that call for the past several years, albeit in our own self-serving way.

The University of Denver is a small private university with a diverse, international population. Each segment has its own distinct needs vis à vis information, and it is the role of the Penrose Library Reference Faculty to ensure that those needs are met in such a way as to promote proficiency in information retrieval and research methods... a necessary life-skill in these days of traffic gridlock on the Information Highway. It is the goal of the Bibliographic Instruction Program at Penrose Library to foster technological self-sufficiency in information retrieval, to support ongoing teaching and research efforts, and to ensure that students and researchers understand their options in a knowledge-based society. An information user must navigate a complex system of databases and command languages in order to conduct a meaningful or comprehensive literature search. The library Reference faculty assists in this navigation process by providing instruction on three different levels:

- We teach all Core students fundamental library skills, basic research methods and elementary information retrieval using the CARL System [Colorado Alliance of Research Libraries] which includes the catalogs of member libraries, along with other commercial databases like UnCover and Expanded Academic Index.
- We then teach students how to manipulate the databases available through OCLC's (Online Computer Library Center, Inc.) FirstSearch System, and the highly specialized databases available through DIALOG.
- Finally we show students, who do not already know, how to navigate the Internet and tap into its vast information resources (Gopher, World Wide Web).

The information systems taught and used in the library vary widely in terms of ease of use, command languages, and structure. For this reason, it is crucial that common threads in all the systems be emphasized. Commonality provides the basis for our bibliographic instruction program. In teaching, we stress: 1) the research process, and 2) basic Boolean logic.

THE RESEARCH PROCESS

The first steps in teaching information self-sufficiency are to teach library users how to look for information:

- How to define research topics clearly by restating the question in a simple declarative sentence, using clear, concise terminology.

- How to determine what tools are appropriate to use by becoming familiar with what resources the library can provide in particular areas of concentration.

- How to execute searches using the command languages specific to certain systems.

- How to physically locate and retrieve desired materials, taking advantage of in-house resources, resource sharing agreements, interlibrary loan, and document delivery services.

All undergraduates enrolled in the Core Curriculum are required to take a course entitled "The Persuasive Voice" (PV) as part of their freshman English requirement. PV is a course designed to teach students critical thinking skills, and basic research methodology. It has a very strong library component, and is one of the key building blocks of the library's Bibliographic Instruction Program. Reference faculty teach the library component, and give the students explanations, handouts and tools that will enable them to develop their own expository and argumentation skills.

Penrose Library, Persuasive Voice 1994-95

STEPS FOR FINDING RESEARCH MATERIALS:

1) Define topic.
2) Write down key terms.
3) Tools (resources) to use. Start with those listed on
"*Penrose Library – Selected Resources*" handout:

A) CARL
Library Catalogs – University of Denver
(Use to find books and periodicals)

Current Article Indexes – UnCover, Expanded Academic Index
(Use to find articles)

Any other applicable database – ERIC, Business Index (Use to find articles)

HINTS: Use "Searching Tips for PAC" handout. Find relevant articles, look at full records, and write down subject headings (called "Other Entries" or "Descriptors"). Execute search again, using subject headings.

B) PRINTED INDEXES

Social Sciences Index
Education Index
Readers' Guide to Periodical Literature
PAIS

HINT: Search by subject heading. Try looking under "See Also" headings within the same volume. Use at least 10 years of each to spot trends in the literature.

4) RETRIEVE MATERIALS

A) BOOKS

Copy down full bibliographic citation (author, title, place of publication, publisher, date), call number, location, and note status (*Checked out, Not checked out, Missing*).

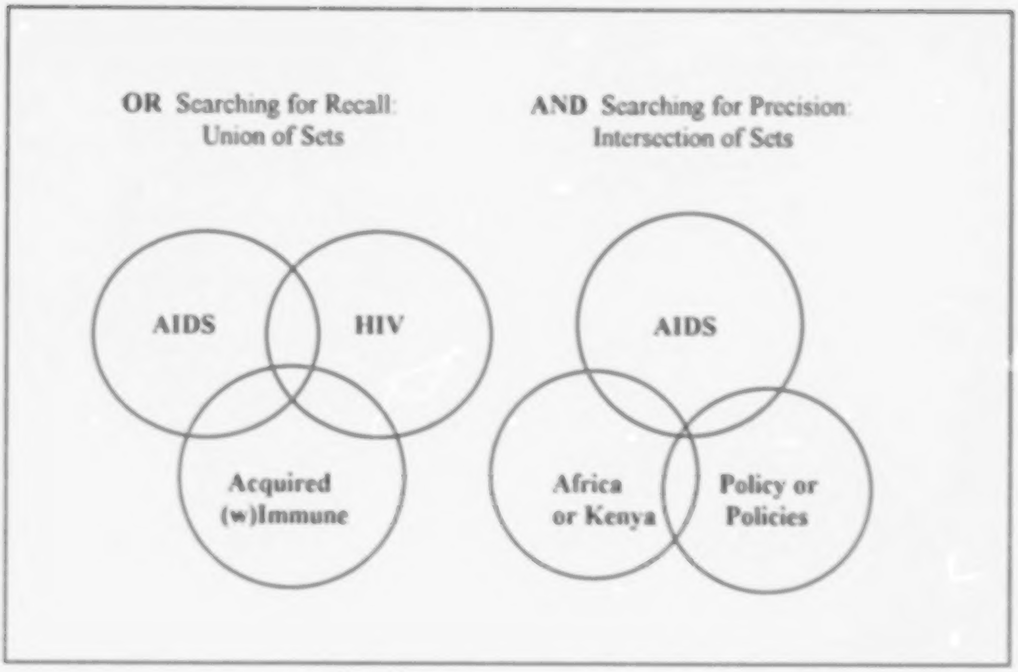
B) PERIODICALS

Search University of Denver's library catalog. (See *"How to Find a Journal at Penrose Library"* handout). Be very sure the journal title you find is the same journal you want. If Penrose does not own the journal, ask a reference librarian at the Information Desk for assistance.

ANY QUESTIONS? ASK!!!

BASIC BOOLEAN LOGIC

Understanding of basic Boolean logic is essential to searching any of the bibliographic tools that are available in electronic format today. In fact, the logical combination of terms and concepts underlies most on-line library and information retrieval systems. Synonyms and related terms are combined to form "concept blocks". These blocks are then logically combined with other concept blocks to create intersecting sets. The areas of intersection contain the materials most pertinent to the question at hand. By starting incoming freshman out with basic Venn diagrams illustrating the concepts of "AND" and "OR", we prepare them for the more sophisticated strategies and more complex systems they will use when they reach their upper division "majors" courses.


OR Searching for Recall:
Union of Sets
AND Searching for Precision:
Intersection of Sets
AIDS
HIV
Acquired
(w)Immune
AIDS
Africa
or Kenya
Policy or
Policies

CARL (PAC) INSTRUCTION

The Penrose Library On-line Catalog is mounted on the CARL System, and is only one of many databases available to users of CARL's member libraries. CARL has essentially five parts:

- Library Catalogs
- Article Indexes
- Information Databases
- Other Library Systems (including FirstSearch)
- News

The search strategies used in searching the public access catalog (PAC) and those used in searching the other databases are essentially the same. Students are taught to read the screens for help, to execute commands using elementary Boolean logic, and to search on the stem of a word using truncation. Enhancements like Boolean logic and truncation are featured in the library catalogs but are not yet available all in the CARL-mounted commercial databases. The rest of the command sequence is the same, however, and help screens are always available. We also encourage our students to learn a set of Quick Search Commands that can be executed from any CARL screen, and can short-cut through the extensive help screens making execution faster, more flexible, and less frustrating. Quick Search is part of initial PV training, and is incorporated into subsequent PAC training, classroom instruction, and library orientation sessions.

QUICK SEARCH

Instead of returning to the first screen of PAC to initiate every new search, try doing a "Quick Search". At any point during your search, you can change strategies by typing two forward slashes (//), followed (no spaces) by the first letter of the type of search, followed by the search itself, followed by <return>:

by name:	**//n Svetlana Alpers**
by word:	**//w Dutch painting**
by title:	**//t art of describing**
by call number:	**//c ND646.A72.1983**
by series:	**//s studies in the fine arts**

NAME/WORD SEARCH

You can try a name/word search if you know at least one of the author's names and a word (or words) from the title or the subject. Separate the name from the words using an forward slash (/):

//n Clark/France art

will retrieve T.J. Clark's The Absolute Bourgeois. Or, if the first and last name of your author are very common, combine the two with a word from the title or subject matter:

//n David Smith/art

If there are too many names for the computer to process (for instance, "Smith" alone), the search may not work. The names of co-authors are not searchable together.

OTHER LIBRARIES WHICH OWN ITEM

If the book you need is checked out, you can find which other libraries have the book. At the end of the full record, choose the option <O>, for "owners" and press <return>. A list of libraries holding that book will appear. To discover if the book is checked out at the other libraries, switch library catalogs. If Penrose does not own a title, try searching in the other library catalogs. Once the item is located, type "O" at the end of the full record to find which libraries own the book.

SELECTING ITEMS FOR FULL RECORD DISPLAY

PAC will display seven shortened record items per screen. To view the full records of selected items, without returning to this initial screen, choose the item numbers and separate by commas. If you want to see items 1, 5, 6, 10, and 15, type these numbers when prompted.

One of the most important skills for students and researchers at DU to learn is how to locate journals and periodicals in the library. Books are, of course, filed by call number and are relatively easy to locate. Bound issues of journals are also filed in a classified arrangement, and anyone wanting to retrieve periodical information must know 1) the Library of Congress classification number, or call number, and 2) the format of the item in question. Some back issues of journals are retained in microform which is housed separately. Locating journals in Penrose seems to be one of the most problematic areas for our students, although once they've learned the call number designations for their own particular areas of interest, they find that they can browse the Periodical Stacks as easily as the Book Stacks.

HOW TO FIND A JOURNAL AT PENROSE LIBRARY:

1) After you have selected journal articles through your research in a paper or on-line article index, you need to use **DU's library catalog**, **database #12** on the **CARL** system, to determine if Penrose owns the periodical and, if so, its location.

2) Do a **title search** on the **title** of the **periodical, journal, or magazine**:

-At the opening screen, type **B** to browse by title, then, on the next screen **T** for title.

-Type in the title of the journal or periodical or magazine, for example:

Journal of Gerontology
Social Sciences Journal
Art Bulletin

(DO NOT TYPE IN THE ARTICLE TITLE!!!!!).

3) The record you need will be the one that says **"DU see record"** on the right hand side of the screen. Type in the record number for that item displayed on the left hand side of the screen to display the full record, for example:

1 Time DU see record

4) You will find the location of the periodical at the end of the full record. If prompted at the bottom of the first part of the full record, press return to see more. **Locations for periodicals** are CurPer (Current Periodicals), Microfilm (Microforms), and Per Stacks (Periodical Stacks). CurPer and Microforms are on the Main Level of Penrose in the Northeast corner. Periodical Stacks are on the lower level. Periodicals are placed in CurPer by title, in Microforms by microfilm number, and in the Periodical Stacks by Library of Congress call number.

CARL also provides a gateway to other library systems. These systems include public, academic, and school library catalogs, some local information databases in the Eastern and Western US. CARL also provides access to selected databases from OCLC's FirstSearch System, allowing users to search files like WorldCat, Medline, ERIC, GPO Monthly Catalog, ContentsFirst, PapersFirst, and ProceedingsFirst.

FIRSTSEARCH INSTRUCTION

FirstSearch is an invaluable tool at Penrose Library. In addition to being selectively mounted on the CARL Platform, the full suite of databases is available through library subscription on workstations in Penrose. FirstSearch provides access to more than 50 databases that provide full-text and bibliographic information on books, articles, theses, films, computer software, and other types of material on a number of different topics. Databases are arranged in categories by subject.

*********** Topic Area Selection ***************

1 Arts and Humanities
2 Business and Economics
3 Conferences and Proceedings
4 Consumer Affairs and People
5 Education
6 Engineering and Technology
7 General and Reference
8 General Science
9 Life Sciences
10 Medicine and Health Sciences
11 News and Current Events
12 Public Affairs and Law
13 Social Sciences
14 List of All Databases

Each topic area contains a number of specific databases pertaining to the same basic subject area. For example, FirstSearch databases included under the general heading of "Life Sciences" include:

• WorldCat	Books and other materials in libraries worldwide.
• AGRICOLA	Materials relating to all aspects of agriculture.
• BioDigest	Non-technical digests in biology, ecology & health.
• BiolAgrIndex	Leading publications in agriculture and biology.
• BIOSIS/FS	A wide range of bioscience topics.

No particular level of expertise is required to navigate FirstSearch. Templates are provided by the system and commands are listed on each screen. If the user has a knowledge of advanced features like Boolean logic and truncation, however, the system will operate using those commands and the resulting search session will be faster and more flexible. FirstSearch has proved to be most valuable in the areas of the Sciences. Because CD-ROM products and on-line databases in the scientific disciplines tend to be quite expensive, searching the concise science files on FirstSearch is a good way to introduce science students and researchers to the benefits of simultaneous electronic execution, and to the techniques used in manipulating the more comprehensive, commercial products.

DIALOG INSTRUCTION

DIALOG contains over 300 scholarly databases and has traditionally been used only by professionally trained databases searchers. In 1993, Penrose library received a $5,000.00 grant from the Social Sciences Foundation (SSF) to offer all members of the university community access to DIALOG through a Classroom Instruction Program (CIP). DIALOG's search system is command-driven and requires the use of Boolean logic for effective searching. A one hour class is required for a user to become a registered searcher. DIALOG is , by far, the most powerful, extensive and difficult system offered to the DU community through the library. Most program participants are graduate students and faculty members.

Instruction begins with the techniques used in creating a well-designed search. The following sample illustrates two building blocks for creating a good search strategy:

- Formulate a question or phrase that defines the topic.
- Break this phrase into concept areas, listing related terms and synonyms for each concept.

Start with a question or statement that best defines your research problem:

**I'm looking for information on what
effect the building of the Aswan High Dam of Egypt had on the people or
culture of the region.**

From this statement the searcher pulls out the relevant search terms and selects synonyms for each term. These synonyms form the major "concept blocks" that will be combined in the actual search:

Formulate your research question into major concepts.

Come up with synonyms for each concept.

Concept 1	Concept 2	Concept 3
ASWAN DAM	CULTURE	EFFECT
Aswan	Cultural	Impact
Assuan	Sociology	Effect
Assouan	Psychology	Influence
	Community	

After the terms and concepts are generated, the student is taught how to combine these terms using Boolean logic. The principles of Boolean logic in DIALOG are the same as discussed earlier. Synonyms are connected with "OR", concepts are connected using "AND". A search string constructed from the above concept list may be (Aswan OR Assuan) AND (cultural OR sociology). In addition to the use of "AND/OR" connectors, DIALOG also allows the use of proximity operators to combine phrases (see below).

Proximity Operators
Combining Search Terms

Use in searching phrases

Use in searching terms or phrases that contain stop words or punctuation

Use in narrowing a search to decrease the number of references

Operator	Example	Function
( ) or (w)	nuclear()reactor	words must be adjacent, in order.
(#W)	locus(1w)control	intervening words, in order.
(N)	disease(N)control	adjacent and in any order
(#N)	market(2N)share	searches "share of the market"

The hour-long instruction includes a review of selected DIALOG commands and analysis of an actual search. Each student receives a handout and a worksheet. The worksheet (below) is designed to further aid the student in the search strategy by providing examples. Searchers are requested to bring a completed worksheet for review by a librarian before they go on-line. This allows the librarians to catch mistakes, help in database selection, and assist in expanding or focusing initial search strategies.

SEARCH STRATEGY FORM

Date & Time of Search________________ Reviewed by______________

Topic statement:

Select Database(s) [B] example: B55,39

Set 1: Search for your first concept with these term(s).

S	OR	OR	OR...

example: s nuclear(w)power(w)plant? or breeder(w)reactor or nuclear(w)reactor?

Set 2: Search for your second concept with these term(s).

S	OR	OR	OR...

example: s earthquake? or tremor? or seismic?

Set 3: Search for your third concept with these term(s).

S	OR	OR	OR...

example: s government(w)polic? or regulation?

Set 4: Combine the concepts and terms using AND.

S	AND	AND

example: s s1 and s2 and s3

Print results. example: T S4/3/1-10

INTERNET INSTRUCTION

The dynamic nature of the Internet creates an instructional challenge for library Reference faculty. Basic instruction at DU is provided for the most common Internet navigational systems available to students on campus. Currently, these are Gopher and the World Wide Web. Consistent with our role as a library, students are taught how to find and retrieve relevant information on the Net. General classes are typically one hour in length. Specialized classes in finding information in different subject areas are also offered. Each class covers:

- Navigation, searching and file management in Gopher
- Navigation, searching and file management in the World Wide Web using lynx and Netscape.
- Telnet
- FTP
- Listservs and Newsgroups

Any demonstration of the above systems and commands quickly illustrates the problems inherent with using the Internet as a research tool. Students see road blocks caused by changing computer addresses, unreliable or out-of-date information and slow response times due to heavy Internet traffic. The time consuming nature of Internet navigation along with the very real rewards of finding valuable documents buried under dead-ends or incomplete information are clearly demonstrated in each class.

CONCLUSION

This paper has attempted to outline techniques for teaching information literacy in an academic setting. At DU, library instruction is conducted whenever possible in a hands-on setting, using microcomputers, modems, and LCD panels. Materials used in Classroom Instruction Programs are carefully developed and are used across-the-board. Examples of some of these have been included as inserts in this paper. Because the Reference faculty at the University of Denver shares the teaching mission of the academic faculty, it is our chief aim to foster technological self-sufficiency in research and information retrieval among the students and faculty of DU. We do this to support ongoing teaching and research efforts at the university, in an effort to ensure that the next generation of academics and professionals may fully comprehend their information options in a complex, knowledge-based society.

INTEGRATING ETHICS INTO UNDERGRADUATE RESEARCH: THE NSF RESEARCH EXPERIENCES FOR UNDERGRADUATES PROGRAM

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While startling scientific breakthroughs have captured public attention during the past few years, so too have headline-making cases of scientific misconduct and conflicts of interest in scientific research. In fact, there have been enough well-publicized instances of scientific fraud and other forms of misconduct in scientific research for the problem to become the subject of several congressional hearings and numerous professional conferences.

No doubt much of this public scrutiny reflects the high ethical expectations of, and a basic esteem for, science. After all, no human endeavor has been so identified with, and dependent upon, a commitment to objectivity, honesty, and truth. However, what is ultimately at stake in the ethical issues involved in these cases is not just the public credibility of science, its continuing social power, and professional autonomy. It is, rather, the health and well-being of humans. No one denies that the future belongs to science and technology, and that the power of science is not neutral to the affairs of states and individuals. But, as we hurtle into the 21st century, the practice of science itself is undergoing radical change, as exemplified by the increasing size, complexity, and commercialization of modern research. This presents its own set of problems, seriously challenging the traditional ethos of science and its capacity to function effectively as an internal, self-regulating system.

Responding to what some scientists have called a "crisis" and others a "sea change" (Flint, 1994: 1), many research institutions have initiated, and several Federal funding agencies have mandated, explicit instruction in the ethical conduct of research. One such endeavor is the inclusion of an ethics component in the National Science Foundation Research Experiences for Undergraduates Program (REU). This paper reports on my experience as the ethics mentor for an eight week REU program in physics at the University of Massachusetts Lowell during the summer of 1994. The positive response I had from participating students leads me to believe that its innovative format and approach is worthy of further development.

1994 UMASS LOWELL REU ETHICS COMPONENT

I. Activities, Content, and Objectives:

The operating principle behind the way I structured the 1994 REU Ethics Component was that if high ethical standards are to permeate and actively guide the research activities of students, the teaching of ethics must be *explicitly* integrated into their learning experiences as a fundamental element. In order to achieve this objective, I extended the approach that the American sociologist Robert K. Merton initiated fifty years ago, and Jacob Bronowski amplified, of "developing an ethic for science which derives directly from its own activity." (Bronowski, 1965: 62) Merton extracted the norms of science from what scientists since the seventeenth century had written about their own work and the nature of science (Merton, 1973), and scientists today appeal to the same general principles in describing the distinctive features of science.

Emulating this approach, I selected instructional materials that provided accounts of or by scientists who have been or are currently involved in highly publicized cases or controversies in which ethical issues are tightly interwoven into scientific concerns. Through the prism of this public record, by carefully reading and discussing the statements and positions of the scientists involved, as well as the responses and strategies of the relevant institutions, the students were able to determine for themselves the place and function of ethical standards in science.

Among the results expected from participation in the activities of the ethics component were that students would:
- better understand, and become sensitive to, the ethical dimensions of scientific research;
- develop the ability to recognize and critically analyze specific ethical issues that arise from various research situations and activities;
- more deeply appreciate how vital high ethical standards are to the practice and future of science.

The cumulative effect of the entire experience, it was hoped, would nurture the ideal of becoming self-reflective, critical witnesses for integrity within the scientific community.

The realization of these results required that the ethics component exert a continuing presence throughout the REU program and that it operate in close alignment with the students' research projects. Therefore, the ethics component was broken up into a variety of activities. For two hours each week, the students met with me as a group to discuss assigned readings, to watch videos depicting scientists addressing debated topics or ethical issues in science, and to analyze specific case studies and research situations. In addition to this, I met with each student twice for extensive interviews and, during the course of the eight week program, conducted numerous informal meetings and discussions with the students and their faculty advisors. The overarching purpose of all these activities was to raise practical ethical questions and situations in a manner that would engage the students in an interactive and personal way.

Since the ethical standards and questions discussed were drawn out of actual cases and events within the history and current practice of science, even the discussion of broad, complex issues did not stray far from the students' immediate scientific concerns and interests. The professional conduct of scientists, the operating norms of scientific research, the ethical issues related to the publication of results, the evolving relationship between scientific research and business interests, and the broader issue of national science policy were examined in the context of such events as the controversy over cold fusion, the race for the superconductor, the cancellation of the supercollider, and the scientific disputes over the gathering and handling of data from the Hubble Space Telescope. For many of the participants, the effort to better understand the ethical dimensions and ramifications of these events resulted in the deepening and broadening of their scientific knowledge.

II. Evaluation Process:

To establish a baseline for measuring the effectiveness of the ethics activities in both the affective and cognitive domain, I conducted entry and exit interviews with the participants and administered written entry and exit questionnaires. (See Appendices A and B.) Also, the students wrote a short essay at the end of program reflecting on ethics in science and/or the experience of participating in the REU ethics component. In order to ensure candid responses, both of the written questionnaires and the final essay were done anonymously. The students used their social security numbers or pseudonyms so that I could carry out a comparative analysis of their entry and exit responses.

A. Analysis of Responses to Entry Questionnaire:

The main objective of the entry questionnaire and interviews was to gather information about the extent, if any, of the students' exposure to ethics or to the role of ethics in scientific research during their undergraduate studies, their initial reaction to and general attitude towards having an ethics component as part of their REU program, and their expectations for this activity. While it is generally recognized that a knowledge of students' backgrounds in a given subject area provides a starting point for effective teaching, it is particularly important in teaching ethics to have some sense of the attitudes and expectations students are bringing to the subject because their attitudes may very well be negative and their expectations low. This is especially true if the time spent on learning ethics is viewed as intruding into, or taking away from, studies perceived to be more important or career oriented.

Many students share the often expressed skepticism about the effectiveness of trying to "teach ethics." This group was no different. One student echoed the attitude of several of his colleagues when he stated, "I feel a certain level of ethics is already in all of us; we don't have to reinvent the wheel." While several responses were overtly negative, the general tone of the initial reaction to the ethics component tilted more towards indifference or skepticism. Two of the eight participants reacted quite positively. Another student, whose initial attitude was negative, admitted on second thought that "it may be a good experience because there is a lot I don't know."

While it is pedagogically sound to be aware of any obstacles students have to learning a skill or subject, it is equally important for the students themselves to be explicitly aware of their attitudes, motives, and expectations. This helps to alert them to their own role in the learning process and can serve as a benchmark for them to make their own assessment of the outcomes.

Although six out of the eight were personally indifferent or negative about studying ethics as part of the REU program, they all agreed that high ethical standards were vital to the practice and future of science. Seven of the eight participants also agreed that the teaching of ethics should be explicitly integrated into their learning experiences. At first glance there may appear to be either a cognitive dissonance embedded in these responses or the mere paying of lip service to the importance of ethics in science. However, there was no evidence of this in their interviews. In fact, the students' replies reflect a fairly typical position, i.e., ethics *is* important in the practice of science, but it is not something one *learns.* A variety of reasons may be given for this, i.e., ethics is a matter of character, upbringing, etc., but, ultimately, on the personal level, most persons perceive themselves as already being, in a fundamental sense, ethical.

The students' answers did indicate considerable vagueness about the meaning of ethics and how it relates to science. Except for one participant who had done extensive reading in the history of physics and was quite knowledgeable about the making and impact of the atomic bomb, the students had done little reading about or given any serious thought to the ethical dimensions of scientific research. There was little explicit awareness of recent publicized cases of scientific misconduct.

The students expressed little concern about the ethics component intruding into their research time. Their position was accurately captured by the response, "If it is part of the work here, so be it." There was a general consensus that two to three hours per week, "much like an undergraduate class" as one student put it, was a reasonable amount of time to meet as a group.

Despite the indifferent to skeptical tenor of their approach to the ethics component, and some uncertainty about its content, the students were positive about the results they expected to gain from it. Their expectations coalesced around the ideas of acquiring "a better understanding of what I am now unfamiliar with," or "a more complete understanding of some of the ethical problems facing science."

B. Analysis of Exit Questionnaire Responses and Essays:

In both their answers to the exit questionnaire and final essay, the REU participants clearly indicated that the ethics component was highly successful in a number of ways. Not only did its approach and the instructional materials capture the interest of all the students and stimulate their own efforts to analyze complex ethical issues and situations, but also they transformed the students' initial indifferent or negative reactions into positive ones. One particularly significant result that followed from the approach taken in the ethics component is that, in addition to being alerted and sensitized to the range and depth of the role ethical considerations play in scientific research, the students acquired new knowledge about physics and the way it is done that differentiates it from the other sciences.

The following sample of excerpts from the students' responses sharply express these accomplishments of the ethics component:

- "My initial reaction was negative. I had already taken an ethics course and I felt that this would just be a rehash of what I already knew. But I found that this ethics course...focus[ed] on ethical questions dealing with actual scientific work rather than generalized ethical questions. I also feel that I had my eyes opened to a part of science that I had not thought too much about before."
- "My initial reaction to this component was a negative one....I now feel it has added an interesting component to the scientific portion of the program."
- "At first I was indifferent to having the ethics program, but I can honestly say now that I'm grateful and thankful for it....I better understand the ethics of science and what has happened in the past. I am more in tune to what's happening....I feel that this class taught me a lot of things I thought I knew, but more importantly, brought a sharper focus to an otherwise fuzzy view."
- "The best part of the course was that it got us to think about ethics. Nothing can be done until people think. Then we may act and correct. It will not happen spontaneously."
- "A close examination of noted cases of misconduct, as we have done, helps the student scientist to appreciate both the problems of misconduct in science as well as the problems and pressures that he will hopefully overcome in the future. All too often, the beginning scientist has little conception of the ethical problems faced by researchers."

- "As we become more and more cognizant of the ramifications of unethical conduct in science in terms of a sullied reputation, sometimes endangering others as in serious misconduct in medical research, and just contradicting the very basis of science as a search for truth, we come into a deeper appreciation of the vital necessity for high ethical standards in science. By open and free discussion of these ramifications in this class, I think all of us have come to appreciate the need for high ethical standards."

The positive assessment reflected in these excerpts mirrors the results of the quantitative rating the students gave to the ethics component. (See Appendix C.) On a rating scale from one (poor) to five (excellent) the students gave the ethics component an overall rating of **4.2**. In regard to the instructional materials (See Appendix D.), they were asked to rate each of the videos the group watched and the assigned readings as a whole in terms of the information they provided, their contribution to the stated objectives of the ethics component, and their interest level. The combined rating for the videos in each category was:

(1)	Information provided	3.9
(2)	Contribution to stated objectives	4.3
(3)	Interest level	3.7

The rating for the assigned readings was:

(1)	Information provided	4.8
(2)	Contribution to stated objectives	4.6
(3)	Interest level	3.8

CONCLUSION

One of the greatest challenges in teaching an ethics course to students in the sciences and other professional programs is to establish its importance and effectiveness. Feedback from the evaluation process built into this REU ethics component provides solid evidence that it met both of these criteria. There were several important reasons for this. First and foremost was the explicit and unqualified commitment to the ethics component by everyone involved in the 1994 REU program, from the principal investigator to the faculty mentors and graduate students who worked with the students on their research projects. There was never the slightest hint that the activities of the ethics component were in any way tangential to the REU program. This was crucial in providing a countervailing resonance to any incipient skepticism about its place and function in the program. This support conveyed to the participants a sense of importance which the ethics component very likely would not otherwise have had.

Secondly, the approach taken in the ethics component of showing the students that the ethical norms governing scientific research arise directly from the standards and demands of the activity itself gave the ethical issues discussed the kind of immediacy and practicality that enabled the students to actively relate to them and to apply them to their own experience as aspiring scientists.

Thirdly, the selection process for the program brought together an intriguing mix of participants with diverse backgrounds and abilities who quickly developed a congenial and supportive working atmosphere. This fostered the kind of discussions in which strong and divergent ideas could be forcefully presented and debated, with everyone contributing and reacting in a positive way.

In the final analysis, however, as one participant concluded, "We can only hope that this class will form a strong foundation on which a young scientist will build for himself a citadel of ethical thought. As Robert Frost reminds us in 'The Road Not Taken,' each one of us will choose a road for ourselves. May we take the difficult and narrow one."

REFERENCES

Bronowski, Jacob. (1965). Science and Human Values. New York: Harper & Row, Inc.

Flint, Anthony. (1994, June 6). "Conduct of Science Called 'Crisis'." Boston Globe, 1 & 5.

Merton, Robert K. (1973). The Sociology of Science: Theoretical and Empirical Investigations. Chicago: University of Chicago Press.

APPENDIX A

1994 REU ETHICS COMPONENT ENTRY QUESTIONNAIRE

1. Do you agree or disagree with the position of the American Chemical Society "that the observance of high ethical standards is so vital to the whole scientific enterprise that a definition of those standards should be brought to the attention of all concerned" (Acc. Chem. Res., Vol. 26, No. 2, p. 75)?

2. If you agree with the American Chemical Society position, do you also agree that if these "high ethical standards" are to permeate and actively guide the research activities of students, the teaching of ethics must be explicitly integrated into their learning experiences as an intrinsic and integral element?

3. If you agree with # 2, from a practical perspective do you think it is possible to achieve it.

4. Is there a required ethical component to your undergraduate program?

5. Have you taken any ethics or ethics-related courses?

6. Have you done any reading about or given any explicit thought to the ethical dimensions of science or scientific research?

7. Have you followed any of the recent publicized cases of scientific misconduct?

8. When did you find out there was an ethics component to this REU program? What was your immediate reaction, i.e., positive, negative, indifferent?

9. Were you at all concerned that it may intrude into the time you want to spend on your research project?

10. What do you think would be the reasonable amount of time the NSF would expect to be devoted to an ethics component of an eight-week REU program?

11. What results would you expect from an ethics component?

12. When this REU program is over, how would you go about evaluating this ethics component?

APPENDIX B

1994 REU ETHICS COMPONENT EXIT QUESTIONNAIRE

I. At the beginning of the REU program, you were asked what your immediate reaction was upon learning that an ethics component was part of the program. Now that you have completed this version of one, to what extent has your initial reaction been changed or confirmed?

II. To what extent was the proper balance achieved between the Ethics Component and your other responsibilities under the REU grant?

Are there any adjustments you would suggest?

III. The UMass. Lowell REU grant application to NSF stated that "among the results expected from the Ethics Component are that the students will:

i / better understand, and become sensitive to, the ethical dimensons of scientific research;

ii/ develop the ability to recognize and critically analyze specific ethical issues that arise from various research situations and activities;

iii/ more deeply appreciate how vital high ethical standards are to the practice and future of science.

Please comment on the extent to which this Ethics Component has or has not contributed toward the achievement of these objectives.

Are you able to offer some alternative objectives an Ethics Component for the REU Program might have?

IV. In terms of your overall learning experience from the REU program, please comment on the extent to which the Ethics Component contributed to, or detracted from, it.

V. During the course of this Ethics Component, we viewed and discussed the following videos:

1. "Knowledge or Certainty"
2. "ConFusion in a Jar."
3. "Race for the Superconductor."
4. "Do Scientists Cheat?"

On a scale from 1 (poor) to 5 (excellent), please evaluate each video in regard to:

A. the information they provide;
B. their contributing to the stated objectives of the Ethics Component;
C. their interest level.

Please feel free to comment on individual videos.

VI. On a scale from 1 (poor) to 5 (excellent), please evaluate the packet of handouts/readings for the Ethics Component in regard to:

A. the information they provide;
B. their contribution to the stated objectives of the Ethics Component;
C. their interest level.

Please feel free to comment on particular handouts and/or readings.

VII. Overall, on a scale from 1 (poor) to 5 (excellent), how would you rate the Ethics Component?

VIII. Please make any suggestions you might have for improving the Ethics Component in regard to approach, structure, or content.

APPENDIX C

1994 REU ETHICS COMPONENT

Student Evaluation

I. Instructional Materials A. Videos	Scale 1 (poor) to 5 (excellent)
1. "Knowledge or Certainty"	
A. Information provided	3.2
B. Contribution to stated objective	3.6
C Interest level	2.8
2. "ConFusion in a Jar"	
A. Information provided	3.6
B. Contribution to stated objective	4.4
C Interest level	4.0
3. "Race for the Superconductor"	
A. Information provided	4.8
B. Contribution to stated objective	4.0
C Interest level	3.8
4. "Do Scientists Cheat?"	
A. Information provided	4.0
B. Contribution to stated objective	5.0
C Interest level	4.0
OVERALL RATING OF VIDEOS:	
A. Information provided	3.9
B. Contribution to stated objective	4.3
C Interest level	3.7
B. Readings:	
A. Information provided	4.8
B. Contribution to stated objective	4.6
C Interest level	3.8
II. Evaluation of Ethics Component:	
Overall rating	4.2

APPENDIX D

1994 REU ETHICS COMPONENT

INSTRUCTIONAL MATERIALS

I. VIDEOS:

Nova. (1988). ConFusion in a Jar. Boston, MA: WGBH Educational Foundation.

Nova. (1988). Do Scientists Cheat? Boston, MA: WGBH Educational Foundation.

Ascent of Man. (1973). Knowledge or Certainty. London, England: British Broadcasting Corporation.

Nova. (1988). Race for the Superconductor. Boston, MA: WGBH Educational Foundation.

II. READINGS:

Altman, Lawrence K. (1993, July 27). "Faith in Multiple-Drug AIDS Trial Shaken by Report of Error in Lab." New York Times, C3.

______. (1994, April 26). "Probe Into Flawed Cancer Study Prompts Federal Reforms." New York Times, C3.

Bishop, Jerry E. (1994, July 14). "Some Scientists Press for Cold Fusion Despite Failure of '89." New York Times, A1 and A4.

Bronowski, Jacob. (1977). "A Sense of the Future" in A Sense of the Future: Essays in Natural Philosophy. Cambridge, MA: MIT Press, 1-5.

Carey, John et al. (1989, May 8). "Fusion in a Bottle: Miracle or Mistake?" Business Week, 100-110.

Chaison, Eric J. (1994). The Hubble Wars: Astrophysics Meets Astropolitics in the Two-Billion Struggle over the Hubble Space Telescope. New York: HarperCollins. (Excerpts.)

Einstein, Albert. (1950). "The Laws of Science and the Laws of Ethics." in Out of My Later Years. New York: Philosophical Library, Inc., 110-111.

Feynman, Richard P. (1988). "Cargo Cult Science." in Surely You're Joking, Mr. Feynman!" New York: W. W. Norton, 338-346.

Flint, Anthony. (1994, June 6). "Conduct of Science Called 'Crisis'." Boston Globe, 1 and 5.

Gosselin, Peter G. (1988, October 19). "Flawed Study Helps Doctors Profit on Drug." Boston Globe, 1, 16 and 17.

Greenberg, Daniel S. (1991, April 8). "Corruption in the Laboratory." Boston Globe, 15.

Hazen, Robert M. (1988). The Breakthrough: The Race for the Superconductor. New York: Summit Books. (Excerpts.)

Hilts, Philip J. (1991, March 26). "How Charges of Lab Fraud Grew Into a Cause Celebre." New York Times, C1 and C5.

Huizenga, John R. (1993). Cold Fusion: The Scientific Fiasco of the Century. New York: Oxford University Press. (Chapter XIII, "Lessons," 215-236; Appendix I, "University of Utah Press Release," 289-291; Appendix III, "Chronology of the Cold Fusion Saga," 294-303.)

Langmuir, Irving. (1985). "Pathological Science: Scientific Studies Based on Non-existent Phenomenon." (1953 lecture, ed. by R. N. Hall.) Speculations in Science and Technology, Vol. 8, No. 2, 77-94.

National Academy of Sciences. (1989). On Being a Scientist. Washington, D. C.: National Academy Press.

Park, Robert L. (1994, June 27) "Congress Versus Science. " New York Times, A17.

Pollack, Robert E. (1989, May 2). "In Science, Error Isn't Fraud." New York Times, A21.

Pool, Robert. (1989, April 28). "How Cold Fusion Happened--Twice!" Science, Vol. 244, 420-423.

Sigma Xi. (1986). Honor in Science. Rev. 2nd. ed. Research Triangle Park, North Carolina: Sigma Xi, The Scientific Research Society.

Storms, Edmund. (1994, May/June). "Warming up to Cold Fusion." Technology Review, 19-29.

Teresi, Dick. (1994, June 11). "Physics Is History." New York Times, 23.

Witte, Marlys H. et al. (1994, June 8). "Kaposi's Sarcoma, Vascular Permeability, and Scientific Integrity." JAMA, Vol. 271, 1769-1771.

A MULTIMEDIA APPROACH TO COMPUTER ETHICS

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In the last half century, computers have played a central role in a technological revolution that history may claim to surpass in scope and influence the industrial revolution of the nineteenth century. In a relatively short space of time, computers have touched nearly every aspect of our lives from business to medicine to communications to education to entertainment. Unfortunately, the major advantages of computers -- their ability to process information in nanoseconds, their capacity to store and access billions of pieces of information -- have created an environment where this power can be mismanaged, both inadvertently and intentionally, with dire consequences. Problems can arise both from the unreliability of hardware and software components as well as from human misuse. Being a comparatively young profession, computer science appears to lack a systematic and binding code of ethics to articulate rules for the responsible use of computers. The classroom would be an appropriate arena for the discussion of situations where such rules might apply.

In an effort to understand the ethical beliefs of college students with regard to computers, several researchers have turned their attention to studying student reaction to situations involving ethical issues. For example, Athy (1993) administered a questionnaire to 65 college students enrolled in graduate and undergraduate programs in computer science and computer information science that depicted several scenarios that students might encounter when they enter the business world. Students were asked to indicate if the characters acted ethically, unethically or if ethics was not involved. The research concluded that the students held significantly different ethical beliefs from professionals. Athy highlighted the need for faculty to include these issues in the curriculum. "I believe a need exists to expose high-tech students, the future IS professionals, to the different situations that develop as a result of our increasingly electronic world" (Athy 1993, p. 364).

However, students who plan to pursue careers in computer science and computer information science are not the only audience for ethical instruction. Almost everyone has become a computer user today. Elementary school children copy software, find sexually explicit information surfing the Internet, and play violent video games. There is a real need to control and monitor the use of computers before the technology we have unleashed engulfs us with its power. The National Computer Ethics & Responsibilities Campaign was formed this past year to address these concerns. Campaign co-chair, Peter S. Tippett, claims the aim of this endeavor is to deal with the "computer ethics void facing America today" (Betts 1994, p. 33). Their plan includes distributing sample codes of ethics and other pertinent materials on Compuserve and the Internet, providing support to teach computer ethics in elementary schools, and in general to heighten the awareness of the public for the responsible use of computer technology. In yet another attempt to educate computer users about appropriate behavior, a group of college professors headed by Frank W. Connolly at American University have put forth a document entitled the "Bill of Rights and Responsibilities for Electronic Learners." Their intention was to assemble a set of rights and responsibilities for students and faculty who use computer networks as well as the educational institutions that provide network services.

With new uses and misuses of computers surfacing at a rapid pace, it is clear that educators have an obligation to expose students at all levels to situations that can cause ethical dilemmas and to provide them with some guidelines of how to act when confronted with these situations. The remainder of this paper will describe a computer ethics lesson of a college computer literacy course using a multimedia presentation system. Student reaction to the lesson will also be discussed.

Multimedia Lessons in Computer Ethics

The course entitled *Computer Applications*, is a core course offered by the Computer and Information Sciences Department at Iona College in New Rochelle, NY, required by all students in the college with the exception of computer science majors. For the past two years, selected sections of this course have been taught with the accompaniment of a multimedia presentation system. Lessons have been developed that integrate text, graphics, sound and full motion video in an attempt to create a more engaging learning environment and one that will promote comprehension and retention. Materials are assembled, digitized, and recorded before the actual "story" or lesson is written. The hierarchical paradigm was implemented, allowing the user to navigate at will through various subtopics on each main topic. The system currently runs on a PS/2 Model 80 under OS/2, using the authoring tool, Audio Visual Connection (AVC). Students who have participated in these classes report that the visual and auditory components are an aid to understanding more clearly the technical subjects. Most of the students responded that the format of the class was a refreshing change of pace and that they looked forward to the class.

Encouraged by their positive reaction, we decided to incorporate a lesson on computer ethics into the curriculum. We believed that the multimedia system would be an excellent environment in which to present various ethical situations. Our goal was to encourage students to think about issues that they had not considered before and to discuss their opinions with their classmates.

The lesson is organized around four major topics: privacy, computer crime, computers in the workplace, and the reliability and feasibility of computers. Text, digitized images of computer use, appropriate cartoons, audio explanations and background music are interwoven to create an atmosphere placing the student "at the scene" of each situation. Each topic begins with a list of concerns in that area. For example, privacy is subdivided into how an individual's privacy may be violated by a credit doctor, a credit card company, the police department, and an employer. A button appears next to each subtopic, allowing the user to delve more deeply at the click of the mouse. Case studies are included that describe in detail a particular scenario related to the issue being studied. One story relates the dilemma faced by a credit card holder whose card was cancelled without notice because his checking account reflected insufficient funds to cover his expenses. Another situation illustrates the salami method of computer crime by describing how a bank clerk was able to siphon several million dollars by transferring very small amounts from customer accounts. Students follow the problems of a man who was incorrectly diagnosed with a terminal illness through the use of a medical expert system. At the end of each topic, the student is presented with a "Points to Ponder" screen, where the main concerns of the topic are summarized and where the student is presented with further "food for thought" on the topic. Students are encouraged to contemplate the appropriateness of relying on computer systems to control the health and safety of the public, the responsibilities of employers towards employees whose jobs have been replaced by computers, and similar themes.

Student Reactions

Students responded enthusiastically to the ethics lesson, eagerly offering their opinions on a variety of issues. They were aware of some of the abuses that computers have generated, such as hackers who have successfully broken into security systems and sabotaged data networks. However, they were startled to learn that some employers monitor employees' performance by counting keystrokes and regulating phone calls and E-mail. The lessons informed them of their rights and responsibilities so that they could better protect themselves against computer abuse.

An informal questionnaire was mailed to the students to which approximately one third of the students responded. Of those responding, the vast majority (about 85%) reported that 1) computer ethics was one of the most interesting topics in the course, 2) the situations were easy to remember, 3) the presentation clarified the issues, 4) the lesson created lively classroom discussion, 5) the multimedia presentation was preferable to a more traditional classroom approach, and 6) the multimedia presentation strengthened their learning experience. Students commented that the lessons "enhanced my knowledge of computer crime and occupational uses...gave a broader approach to the subject...should be expanded to other classes...were a change of pace..appealing because [it was] more person-oriented."

Two of the sections using the multimedia system were videotaped during the presentation of the computer ethics lesson. With the assistance of the Mass Media Department at Iona, the tapes were edited to include the actual multimedia presentation of selected topics, followed by some of the classroom discussion that was engendered by the issues studied. The videotape provides others with a synopsis of the use of these lessons and student reactions. We hope to encourage other faculty to incorporate this treatment of the topic into their courses. The videotape is also invaluable to determine how the lessons can be improved for the future. Since new uses and misuses of computers are always on the horizon, it is essential to keep the presentations current and relevant for the student body.

Computer ethics must continue to hold an important place in the college curriculum so that our future citizens are intelligent users of technology. Awareness of these issues can be taught in a variety of ways. At Iona, we have found that using the power of multimedia to present ethical situations is an effective way to educate our students and warn them of the serious problems that may arise when computer users fail to behave responsibly.

References

Athy, Susan (1993). A comparison of experts' and high tech students' ethical beliefs in computer-related situations. Journal of Business Ethics, 12(5), 359-370.

Bailie, Frances & Ricardo, Catherine (1993). Using multimedia to teach computer literacy. Bulletin of Science, Technology and Society (pp. 89-91). University Park, PA: STS Press.

Betts, Michael (1994). Campaign addresses computer ethics 'void'. Computerworld, 28(24), p. 33.

DeLoughry, Thomas J. (1994). Two-year effort results in a computer users' 'Bill of Rights'. Chronicle of Higher Education, 40(38), p. A20.

Forester, Tom & Morrison, Perry (1990). Computer ethics: cautionary tales and ethical dilemmas in computing. Oxford, England: The MIT Press.

Mace, Scott (1994). Campaign puts focus on ethics in computing. Infoworld, 16(27), p. 17.

DEVELOPMENT OF AN UNDERGRADUATE ENVIRONMENTAL CURRICULUM IN BANGLADESH

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During the 1993-94 academic year, the first bachelor's degree program in environmental science and management in Bangladesh was launched at the newly established Independent University, Bangladesh (IUB) in Dhaka. IUB was founded by the Education, Science, Technology and Cultural Development Trust, a Bangladeshi nonprofit, philanthropic organization based in Dhaka, and the founding president of IUB is Dr. Majeed Khan. IUB's stated mission is to contribute to sustainable economic growth in Bangladesh by providing higher education that meets international standards.

The university began to matriculate undergraduate students and offer coursework leading to Bachelor of Science (B.Sc.) Honours degrees in 1993. The faculty, staff and student body of IUB are predominantly Bangladeshi. The author of this paper taught as a volunteer at IUB during the 1993-94 academic year, and is now acting as an American liaison for IUB

The Context

Bangladesh, one of the world's poorest and most densely populated nations, suffers from a panoply of severe environmental problems including cyclones, monsoon flooding, inadequate sanitation, unsafe drinking water, severe overcrowding in slums and squatter settlements, water rights disputes with neighboring India, deforestation, and minimal industrial pollution control. Globally, there is no precedent for so many people--120 million--living in such a small land area (equivalent in size to New York state). Bangladesh's environmental dilemmas are exacerbated by rapid population growth and explosive urbanization as landless villagers migrate to the few large cities in conjunction with the nation's industrialization.

Bangladesh has a history of sending many of its best students abroad to the United Kingdom, United States, India or elsewhere for higher education; many of these students permanently relocate in other countries. The development of an environmental curriculum at a domestic university is essential to prepare environmental professionals to deal with Bangladesh's burgeoning environmental problems.

Curriculum Development

The IUB environmental curriculum was created through the efforts of numerous faculty members, consultants and the 17 members of the university's International Advisory Panel, which includes representatives of universities and nongovernmental organizations in Belgium, Canada, France, the Netherlands, the United Kingdom, and the United States. Realizing the importance of international linkages in higher education, IUB has signed an agreement with the Free University Brussels for faculty and student exchange, and is negotiating a number of similar agreements with other universities abroad.

IUB's B.Sc. Honours programme in environmental science and management was designed to provide focused interdisciplinary study in the natural and social sciences for students planning to go on for graduate studies in environmental disciplines, as well as for students preparing for environment-related careers in industry, government, nongovernmental development organizations and consulting. The four-year curriculum, based on the American credit-hour and semester system, was developed to provide students with the analytical and communication skills, theoretical knowledge, and understanding of societal issues to function within Bangladesh's complex ecological and socioeconomic framework and to deal effectively with their country's pressing environmental and human development concerns.

The Curriculum

The IUB environmental science and management curriculum requires satisfactory completion of 120 credit hours, typically spread over 8 semesters of full-time study. English is the language of instruction. The program requirements include:

A. 35 credit hours of foundation courses including English skills, computer skills, mathematics through calculus, physics, introductory environmental sciences, national culture and heritage, and an intensive inter-term live-in field research experience.

B. 54 credit hours within the environmental science and management major including:

(1) 24 hours of core courses including environmental chemistry; environmental biology, ecology and conservation;

environmental economics; geographic skills (remote sensing, cartography and geographic information systems); public relations in environmental management; probability and statistics; and social science research methods.

(2) 18 hours within an area of concentration, either population and environment or general environmental management.

(3) 12 hours in a semester-long internship, a senior thesis, or a semester of study abroad.

C. 15 credit hours in a minor such as business management, computer science, or development communications.

D. 6 hours in a second international language.

E. 10 credit hours of electives.

The Future

IUB's first graduates will be completing their B.Sc. Honours degrees in 1996 and 1997. At present the university is developing other areas of concentration within the environmental science and management program, and is beginning to outline a graduate-level program in the environmental sciences.

What We Learn From Role Playing In AN STS Activity

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Teaching and learning in Taiwan have been strongly affected by national curriculum standards and joint entrance examinations. Therefore, it is difficult to implement STS learning in the schools, although many educators realize its importance. To overcome this difficulty, the National Science Council Division of Science Education launched the STS movement through promoting science education research (Wang, 1995).

STS education is distinctly different from traditional schooling. It is different from what teachers were prepared to deliver (Rubba, 1991). The beliefs and the values that direct the practice of science teaching by a science teacher have been constructed out of the education that they received and their own science teaching experiences. Before appropriate STS teaching can be fully developed and put into practice, science teachers' beliefs and values must be compatible with the notion of STS education. STS teacher education will be successful only if we employ strategies that help science teachers construct appropriate beliefs, values, and professional practices as they learn to understand STS education (Rubba, 1991).

This study makes three assumptions: (1) Citizens literacy in STS must be cultivated through STS-related social issues; (2) STS literate students can be cultivated only by STS literate teachers; (3) STS pedagogical content knowledge (PCK) can be constructed only through actually participating in STS learning.

Purposes

This study is to design a learning context in which preservice teachers would be able to construct the PCK necessary for the STS teaching. They will involve themselves in a problem centered STS activity using role playing, small group cooperative learning, and class sharing, while videotaping the entire process. The videotaped activity would provide occasions for articulation and reflection. In the course of such an STS activity, students would confront inconsistencies between traditional and STS instruction and come to construct more appropriate beliefs, values, and science teaching practices.

Method and Procedure

The interpretive research methodology (Erickson, 1986; Gallagher, 1991) was used to analyze the changes in the views on learning and in the teaching practices of preservice teachers (senior students) through participating in an STS activity.

The author had 24 senior students conduct an STS activity, meeting one hour each week, at Department of Chemistry, National Taiwan Normal University. The students have taken courses as chemistry majors for the ordinary four-year college students. In addition, they have also taken courses in pedagogical knowledge.

The STS activity proceeded as follows (Fig. 1).

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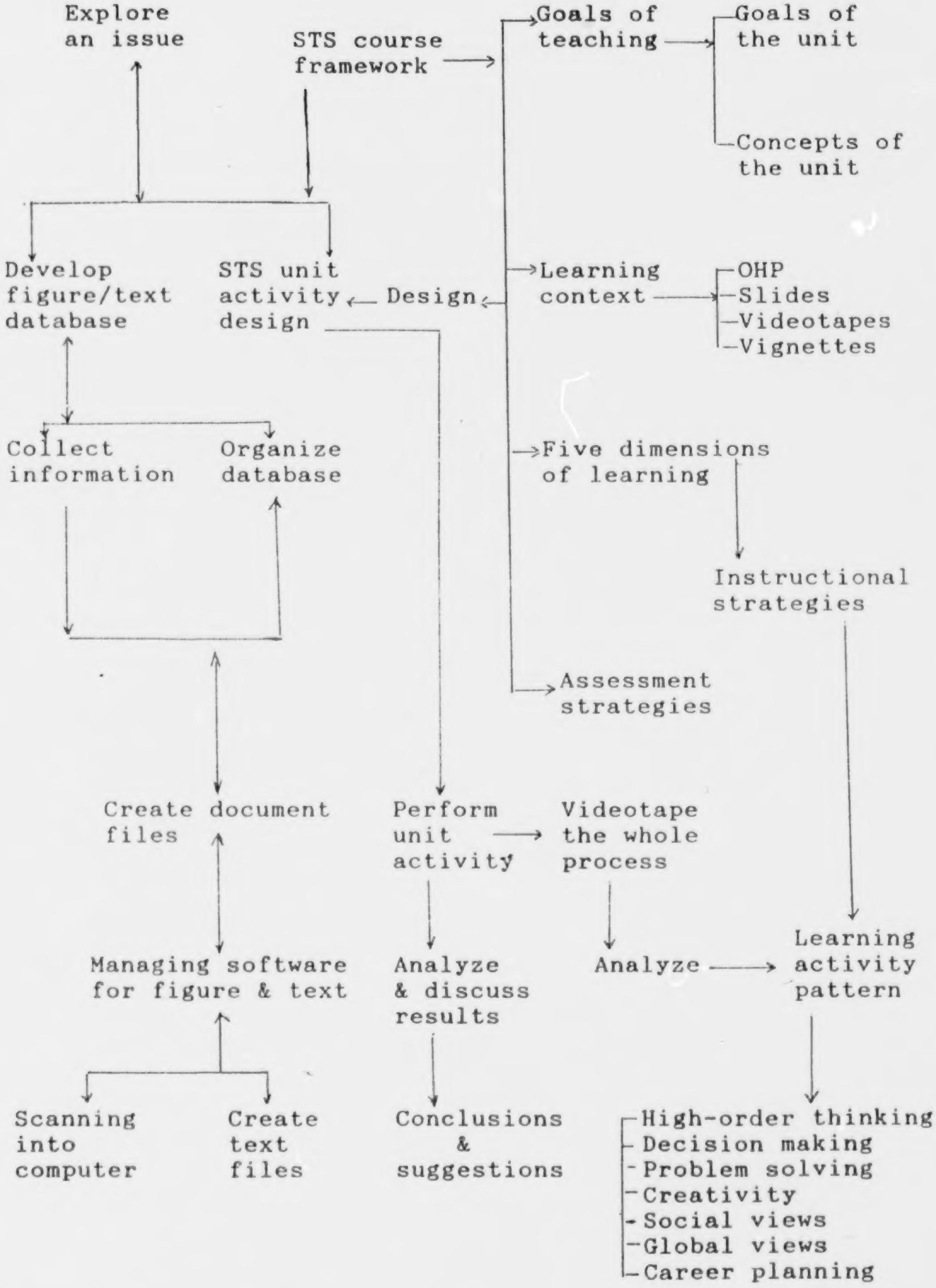
Explore an issue
STS course framework
Goals of teaching
Goals of the unit
Concepts of the unit
Develop figure/text database
STS unit activity design
Design
Learning context
OHP
Slides
Videotapes
Vignettes
Collect information
Organize database
Five dimensions of learning
Instructional strategies
Assessment strategies
Create document files
Perform unit activity
Videotape the whole process
Managing software for figure & text
Analyze & discuss results
Analyze
Learning activity pattern
Scanning into computer
Create text files
Conclusions & suggestions
High-order thinking
Decision making
Problem solving
Creativity
Social views
Global views
Career planning

Figure 1. Procedure for developing STS unit activity

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1. Lecture and scaffolds

A lecture before the STS activity: Students were introduced in a three-hour lecture to (1) a brief history of the STS movement, (2) STS learning goals, and (3) Types of STS activities and instructional and assessment methods for STS learning as cognitive scaffolds (Rosenshine et al., 1992).

2. Finding STS issues and topics

Critical articles in newspapers about cooking oils in Taiwan being contaminated by leaking PCB (polychlorobiphenyls) from heating pipes prompted students to find some problems, from which "How to select cooking oils" and "Analysis of cooking oils" were chosen as topics for activities.

3. Forming small cooperative learning groups

Students selected role playing (Fig. 2) as the type of activity and formed several small role-groups (6 students in a group). Each group took up one role, such as consumers, manufacturers, teachers, and government agents consisting of EPA (Environment Protection Administration), FDA (Food and Drug Administration), and Health Department.

4. Designing the activity

Using the small group cooperative learning method (Wheatley, 1991), each group designed an STS activity plan including objectives, types of student activities, and instructional/assessment methods (scenarios with short illustrative stories, challenging questions, etc.)

5. Performing the STS activity

All groups met to perform the activities, which were video-taped. Student reactions toward the activity were collected

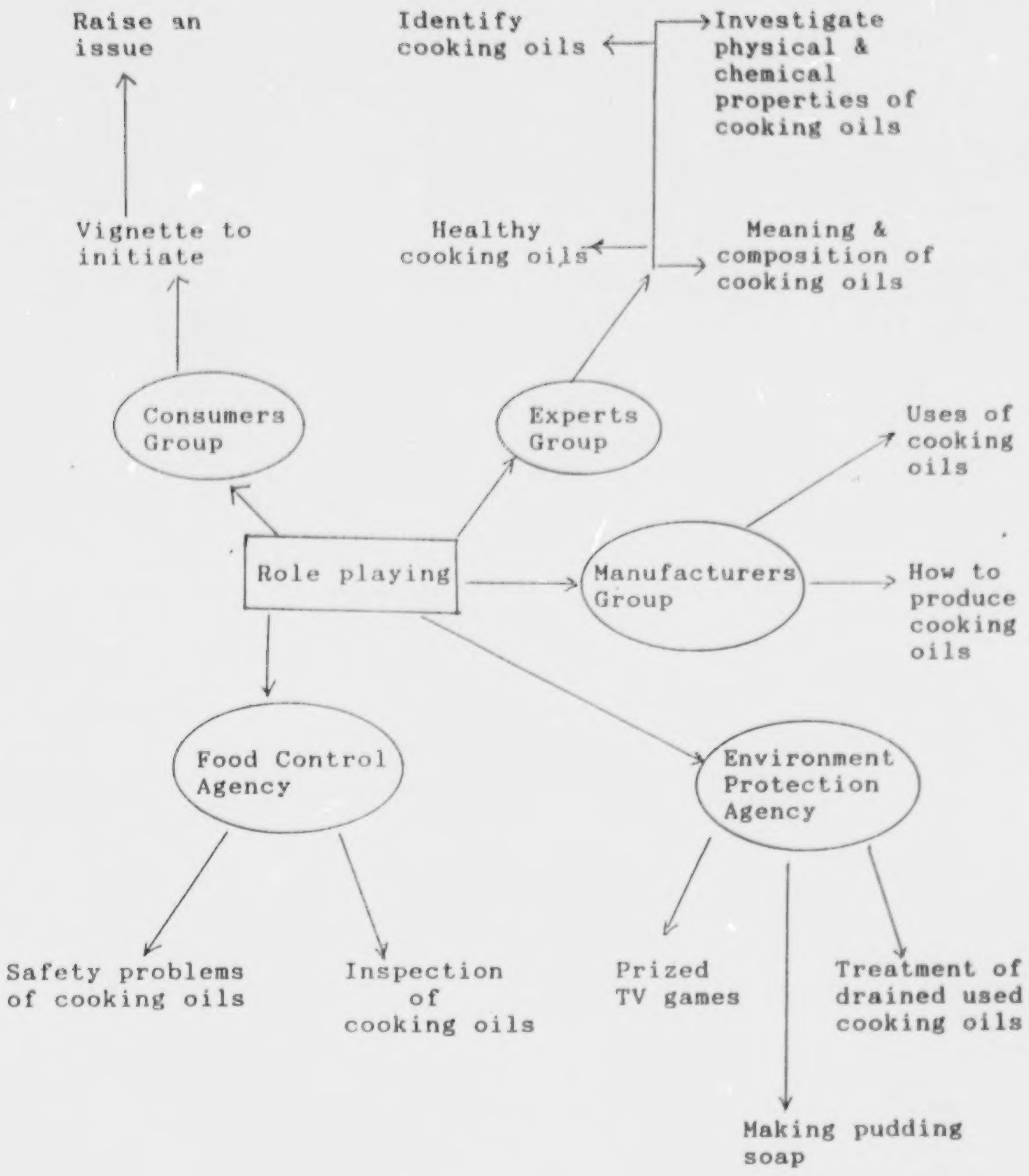
Raise an issue
Identify cooking oils
Investigate physical & chemical properties of cooking oils
Vignette to initiate
Healthy cooking oils
Meaning & composition of cooking oils
Consumers Group
Experts Group
Uses of cooking oils
Role playing
Manufacturers Group
How to produce cooking oils
Food Control Agency
Environment Protection Agency
Safety problems of cooking oils
Inspection of cooking oils
Prized TV games
Treatment of drained used cooking oils
Making pudding soap

Figure 2. Role playing directed STS activity "Cooking Oils"

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6. Viewing the videotaped activities

Each group viewed the videotaped activities and logged educationally significant events for class discussion.

7. Class sharing (Wheatley, 1991)

Groups presented the troubles encountered during the STS activity for class discussion, which was videotaped. Each student wrote reaction notes to the discussions. These notes were collected.

Data were collected from the following sources:

1. Observing the STS activity (in person and on video-tapes)
2. Observing the class discussion (same as above)
3. Notes of students' reactions to the STS activity
4. Notes of students' reactions to the class discussion

Findings, analysis, and discussion

In the STS activity of no set procedure, participants were able to find troubles and their solutions. They constructed not only science knowledge but also teaching and learning strategies. The troubles and the solutions were collected, analyzed, and discussed. Triangulation in data collection was employed to enhance validation of the findings.

1. About the STS lecture and finding topics for activities

In search of topics from the issue "Leaking PCB", students ended up with something like "Analysis of cooking oils" rather than a social issue such as health hazards that consumer victims had been suffering. This indicates that they could not construct appropriate beliefs, values, and STS learning merely by attending the STS lectures, even with hands-out designed to promote scaffolding. The goals and strategies of STS were difficult to transmit to students by the traditional teaching methods. The choice of "Analysis of cooking oils" is obviously the result of their training backgrounds. They went into an STS activity on this topic only to find these disappointments (A.1-5).

A. (1) The topic is a matter requiring chemistry knowledge.
   (2) It is not intriguing.
   (3) It is not open-ended.
   (4) It is not related to the real life.
   (5) They find their thinking and deciding limited, owing to insufficient chemistry backgrounds.

Now they were in trouble, however, this observation turned out to be fortunate. They felt it necessary to discuss in the class sharing about the procedures of finding good topics and agreed upon the following steps B.1-6).

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B. (1) The students should form several role-groups.
(2) All students should find questions in the issue and pick a tentative topic for activity.
(3) Each role-group should take up the questions pertinent to the role; other questions may be added if necessary.
(4) Each role-group should discuss and design the procedures of STS activities for the topic in which all students will participate to solve the questions.
(5) All roles exchange written reports on questions and activity procedures.
(6) All students should participate in discussions about the appropriateness of the questions and the procedures of the activities designed by each role-group.

The STS activity they find most appropriate is accepted. Otherwise, they will go back to step (2) to find another topic.

From these experiences they concluded that good STS activities should be able to do the following (C.1-6).

C: (1) To promote discussion and communication
(2) To use "what if" questions
(3) To use the students' own methods
(4) To make decisions
(5) To extend
(6) To amuse

For example, they considered, in this framework, the topic "Solar energy" is better than "Nuclear energy." This finding is in agreement with constructivist views that: (a) learning is a process of building up structures of experience; (b) learners do not transfer knowledge from the external world into their memories; (c) learners create interpretations of the situation based upon their past experiences and their interactions with the situation; (d) experience in which an idea is embedded is critical to the individual's understanding and ability to use the idea.

2. About role playing

In the STS activities the students found these shortcomings (D.1-4).

D. (1) Role playing restricted thinking
(2) Role players sticked too much to the roles assigned
(3) Some were unfamiliar with the roles assigned
(4) Merely by role playing, questions could not be thoroughly discussed and the answers found.

During class sharing, they discussed over the shortcomings and arrived at these solutions (E.1-5).

E. (1) Adapt other activity styles such as debating.
(2) Keep or exchange roles.
(3) Volunteer roles other than the assigned.
(4) All members should engage in serious brainstorming and discussion to obtain solutions without regard to the roles assigned.
(5) Switch from role playing to debating for more complicated problems.

They also found these merits (F.1-5) in role playing.

F. (1) Brain storming facilitated
   (2) Issue awareness aroused
   (3) Many questions found
   (4) Multiple perspectives opened out
   (5) Relative positions assumable

This finding of shortcomings, solutions, and merits is in line with the constructivist view that earning grows out of one's own experiences in authentic contexts. Thus, unlike the explain-practice paradigm, the problem centered activity gave a rich environment in which the students construct PCK specific to the subject matters of the topic under consideration. According to Shulman (1986) PCK is a type of knowledge in which teachers relate their pedagogical knowledge (what they know about teaching) to their subject matter knowledge (what they know about what they teach). Cochran (1991) added that PCK is highly specific to the concepts being taught and develops over time as a result of teaching experience, which is the case as observed to happen here.

3. The STS activity

After performing the STS activity, they found the following undesirable phenomena (G.1-7).

G. (1) The heart of the problem was not thoroughly discussed.
   (2) One-hour sessions allowed only discussion of the predetermined problems.
   (3) There was no time for discussion of problems raised in the class.
   (4) There was too little mutual discussion.
   (5) Some students had few opportunities to speak.
   (6) Some students tended to stay silent.
   (7) Some students felt not at home.

At the class sharing period they discussed these matters, which were attributed to the following causes (H.1-5).

H. (1) Not all members participated in the design of the activity.
   (2) The questions discussed were not preliminary exchanged among all roles.
   (3) Brainstorming was insufficient.
   (4) Some students were unfamiliar with brainstorming.
   (5) Some students were unfamiliar with the activity procedures.

They arrived at the following solutions (J.1-9).

J. (1) All students should participate in design of the activity as described in B.1-6.
   (2) The activity should be well directed.
   (3) It is more important to thoroughly discuss the major problems in the topic than covering many problems superficially.
   (4) The members of each group should sit together in the activity to facilitate mutual discussion when questions arise.
   (5) Group members should play as a spokesperson in turn, who speaks for the group.

(6) Two hours may be allocated to a session.
(7) All students must try hard not to waste time.
(8) Free mutual discussion should be encouraged.
(9) For unsolved problems, more information should be collected as homework for use in the next session.

4. The videotaped activities

In the viewing of the videotaped activity, the students verbalized their thinking and pondered their action. These discussions provided opportunities for each member to compare own design and beliefs with those of others, i.e., articulation and reflection. They learned the importance of feedback from the videotaped activities. In this learning environment, they developed intellectual autonomy as judged from the following findings (K.1-3).

K. (1) A forum was observed to have developed which provided a context in which they were discussing problems encountered in the activity, constructing explanations of their thinking, and finding solutions by class sharing.
(2) Through the exchange of ideas with peers, students were observed to have developed shared meanings that allowed them to communicate effectively with each other.
(3) The class sharing finally solved (such as E. 1-5) all the encountered problems to reach consensus. By then the instructor's points had been almost covered.

The learning contexts during this discussion were as follows.
(1) The instructor made a conscious effort not to judge right or wrong, but to encourage creation of a variety of methods and their elaborations. The instructor also checked if the learners were developing: (a) self-awareness of the constructive process; (b) the context-specific nature of interpretations; (c) the value of multiple perspectives; and (d) the relativity of positions (Duffy & Janassen, 1991). (2) Students were given intellectual autonomy, and they had to negotiate differences and work toward consensus. (3) With videotaped activity, they could see themselves teach and hear constructive criticism. Each one had chances to see and talk through situations that were giving them troubles (Armbruster et al., 1991).

5. "Problem centered", "small group cooperative", and "class sharing" learning strategies

Although with the STS goals in their minds, the topic they picked up at the very start (Analysis of cooking oils) led them to realize they could not achieve the expected goals with the topic having shortcomings described in A.1-5. Such cognitive disequilibrium prompted them to find the causes (B.1-6) and the solutions (C.1-6), in the process of which PCK was constructed. Thus, students were observed to have solved the pedagogical as well as STS problems having no known procedures, being able to select topics and the learning strategies suitable for STS activities at the end of such a short period of time.

6. The traditional educational background

Causes of the shortcomings due to the traditional educational backgrounds were found to be the following (L.1-6).

L. (1) The topic they picked up initially had the shortcomings as shown in A.1-5.
(2) Expectation for an immediate answer to the question asked.
(3) Expectation for the issue to be settled with one correct answer.

(4) Various methods such as role playing, videotaped activities, small group, cooperative learning, class sharing, do not conform with the education environment and system.
(5) Doubting the possibility of STS learning in secondary schools.
(6) Uncertain of instructional strategies (how to construct self-regulation, critical thinking, and creative thinking, decision making, problem solving) and the corresponding assessment strategies.

They outlined the solutions as follows (M.1-2).

M. (1) After each group finishes the activity, all groups should hold an assembly to mutually discuss, criticize, and check the shortcomings, to find suitable assessment and instructional methods by comparing and criticizing available methods provided in the scaffolds.
(2) They must learn those assessment and instructional methods that they do not yet know, such as "how to assess the effects on brainstorming", etc.

7. Other findings

N. (1) Students recognized and valued the strong theory-practice link.
(2) They appreciated the comments and suggestions entered by the instructor in their dialogue journals.
(3) They rated the cooperative learning method higher than the traditional as seen in the various feedbacks.
(4) They complained about a work load much heavier than the traditional work load.

Conclusions and suggestions

1. Students must learn from acting in authentic contexts to become good teachers. "Learning by doing" is a powerful tool for educating science teachers to improve their views and professional performances.
2. PCK can be developed through a problem centered STS activity.
Favorable conditions for learning exist when a person is faced with a task for which no known procedure is available. Students can deal with the tasks at their cognitive levels using their preferred styles.
3. Problem centered cooperative learning triggers natural instincts to construct PCK. The students come to realize they are capable of problem solving without having to wait for the instructor to show them procedures or give the answers.
4. The instructors must learn to look at the problems through the students' eyes. The instructor should regard students' errors as rich sources of information about their thinking rather than mistakes to be corrected.
5. Role playing is useful in facilitating brainstorming, arousing issue awareness, finding questions, expanding multiple perspectives, and assuming relative positions.
6. Students should be given intellectual autonomy, encouraging them to negotiate differences and work toward consensus.
7. The videotaped activity should be used more often to provide opportunities for articulation and reflection.
8. Teachers training institutes should provide a formal STS course so that they can have opportunities to design and use their own STS activities to construct PCK.
9. They are also encouraged to maintain their efforts on the same line to assure that college training would not become only cosmetic.

10. STS literate students can be cultivated only by STS literate teachers.

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References

Armbruster, B. B., Anderson, R. C., & Mall, V. C. (1991). Preparing teachers of literacy. Educational Leadership, November, 21-24.

Cochran, K. F. (1991). Pedagogical content knowledge: Teachers' transformations of subject matter. NARST NEWS, September, No. 27, 7-10.

Duffy, T. M. & Jonassen, D. H. (1991). Constructivism: New Implications for Instructional Technology. Educational Technology, May, 7 - 12.

Erickson, F. (1986). Qualitative research on teaching. In M. C. Wittrock, Ed., Handbook of Research on Teaching (3rd ed.). New York: Macmillan.

Gallagher, J. J., Ed. (1991). Interpretive Research in Science Education. NARST Monograph, No. 4, Manhattan, Kansas: National Association for Research in Science Teaching.

Rosenshine, B. & Meister, C. (1992). The use of scaffolds for teaching higher-level cognitive strategies. Educational Leadership, April, 26-33.

Rubba, P. A. (1991). Integrating STS into school science and teacher education: beyond awareness. Theory into Practice, Autumn, 303-308.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4-14.

Wang, C. H. (1995). STS in Taiwan. International Science Education, 6 (1), 17-18.

Wheatley, G. H. (1991). Constructivist perspectives on science and mathematics learning. Science Education, 75 (1), 9-21.

An STS Activity - Ozone Depletion

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The STS movement is an educational reform designed to promote citizens' science literacy in this technologically dominated society. The National Science Teachers Association in the USA has defined STS as the teaching and learning of science in the context of human experience. Many persons regard STS learning as constructivist learning (Yager, 1993).

STS learning is distinctly different from the types of learning in the traditional science class. It was found that scaffolds are necessary for first time STS learners (Wang, 1994). The purpose of this paper is to report a way of scaffolding, which gradually decreases as the STS activity progresses and the learners become more independent in STS learning.

Methods and Procedures

An action research methodology was used to find out whether or not the instructional design is able to promote students' views, skills, and knowledge on the topic.

In the process they examined, confronted inconsistencies in, promoted open-ended thinking on, and constructed knowledge, skills, and views, pertinent to a real life problem," ozone depletion".

1. Subject

The subjects of this study were 32 sophomores (17 males and 15 females) at this Department.

2. Developing "Ozone Depletion" Units

The units were developed as follows (cf. Figure 1).

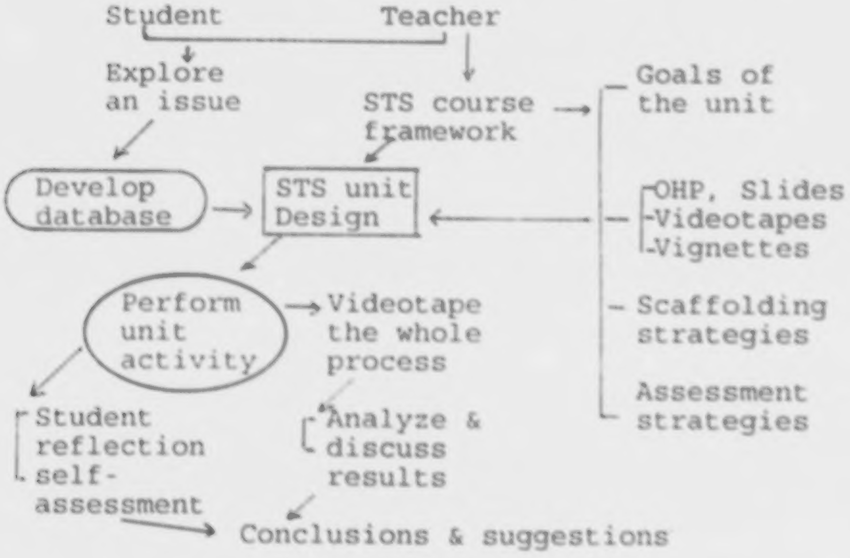
Student
Teacher
Explore an issue
STS course framework
Goals of the unit
Develop database
STS unit Design
OHP, Slides
Videotapes
Vignettes
Perform unit activity
Videotape the whole process
Scaffolding strategies
Assessment strategies
Student reflection
self-assessment
Analyze & discuss results
Conclusions & suggestions

Fig. 1. Procedure for developing STS unit activity

(a) reviewing problems with traditional views of science and science teaching;

(b) reviewing instructional and assessment strategies;

(c) selecting " Ozone Depletion" as an STS topic to develop decision making abilities with high order thinking, moral value, and global views emphasized;
(d) collecting information and developing relevant data bases;
(e) developing a prototype unit consisting of unit goal, chemistry concepts, and learning context/environments;
(f) having the students perform STS learning activities which were videotaped;
(g) revising the developed unit.

3. Dimensions of Learning

Wang (1994) synthesized a set of five learning dimensions based on the works of Waks (1992), Marzano (1992), Sia et al. (1986), and Hines et al. (1991): Dimension 1, awareness of issues; Dimension 2, understanding; Dimension 3, decision making; Dimension 4, responsible action; and Dimension 5, STS literate personality. The five dimensions of learning do not function in isolation or in a linear order, rather, they function as interacting factors to be considered in the learning process. They were used to improve the quality of STS teaching and learning.

4. Instructional media

Instructional media consisted of scenarios and STS vignettes related to the topic "Ozone Depletion," were developed to motivate and maintain students' interest in the topic. STS vignettes consisted of a short illustrative story, challenging questions, and paradoxes related to the STS issue "Ozone Depletion."

5. Instructional Strategies

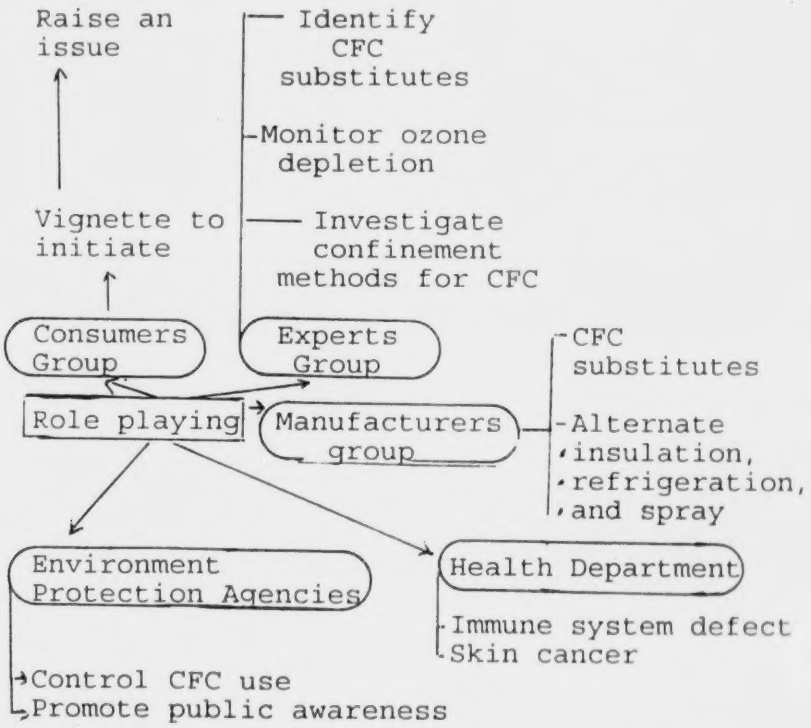
Raise an issue
Vignette to initiate
Identify CFC substitutes
Monitor ozone depletion
Investigate confinement methods for CFC
Consumers Group
Experts Group
Role playing
Manufacturers group
CFC substitutes
Alternate insulation, refrigeration, and spray
Environment Protection Agencies
Health Department
Immune system defect
Skin cancer
Control CFC use
Promote public awareness

Figure 2. Ozone Depletion STS Activity: Role Playing

Instructional strategies using problem-centered cooperative learning consist of: (1) small group learning which involves: (a) collecting data and information, (b) analyzing data and information, and (c) small group discussion; (2) class-sharing which involves: (a) brain storming; (b) role playing as consumers, manufacturers, environment protection administration, health department, and scientists (Figure 2); and (c) debating, with which to achieve deep thinking on the issue, make decisions, and propose solutions for social problems. The strategies utilized were designed to encourage students to use an information processing approach emphasizing the ways situational information is perceived, selected, organized, and interpreted. The learning dimensions of Wang (1994) were used as the dynamic framework to sequence the learning activities. Students were motivated to identify important issues and the related tasks. Then they were encouraged to identify the declarative and procedural knowledge needed to complete the tasks. They were further guided to identify the extending and refining activities needed to complete the tasks.

6. Assessment Strategies

(1) Scoring Method for Open-ended Thinking on the Topic

The teachers' levels of cognitive complexity in the open-ended thinking on the STS issues were scored by the McDaniel's 5-point scale measurement. The test examples and the rating in the book (McDaniel & Lawrence, 1990) were used for interrater reliability (Wang & Tsai, 1994). Each of the five levels is defined as follows.

Level 1 (1 point): Unilateral Descriptions. The student (i) simplifies the situation, (ii) focuses on one idea or argument, (iii) brings in no new information, meanings, or perspectives, (iv) makes good/bad, either/or assertions, (v) appeals to authority or simple rules rather than supporting ideas, and (vi) repeats or paraphrases information presented.

Level 2 (2 points): Simplistic Alternatives. The student (i) identifies simple and obvious conflicts without pursuing or analyzing, (ii) develops a position by dismissing or ignoring one alternative and supporting the other with assertions, and (iii) does not make deeper assessment of the situation.

Level 3 (3 points): Emergent Complexity. The student (i) identifies more than one possible explanation or perspective, (ii) establishes and preserves complexity, (iii) introduces new elements, and (iv) supports their position through comparisons and causal statements.

Level 4 (4 points): Broad Interpretation. The student (i) uses broad ideas to help define and interpret the situation, (ii) manipulates ideas within the perspective established, (iii) has a clearly recognizable explanatory theme, and (iv) integrates ideas into "subassemblies," each supporting a component of the explanation.

Level 5 (5 points): Integrated Analysis. The student (i) restructures or reconceptualizes the situation and approaches the problem from a new point of view, (ii) constructs a network of cause-and-effect relationships, (iii) integrates and extrapolates ideas, (iv) arrives at new interpretations by analogy, application of principles, generalizations, and world knowledge, and (v) constructs an organizing framework, links connections, and predicts consequences (McDaniel and Lawrence, 1990).

McDaniel's levels 1 and 2 were combined into the lower level in Table 3, because the learners' responses were mostly descriptions of the situation. Levels 3 and 4 were combined into the higher level, because the learners were able to explain how parts of the situation were interconnected (levels 3 and 4), their responses being noticeably analytic (levels 4).

(2) Assessment on Degree of Participation

Degree of participation (DP) is assessed taking into consideration the following three factors: information collection (IC) (30%), frequency of comment (FC) (40%), and quality of comment (QC) (30%), based on students' performance in (a) contributing ideas or identifying problems; (b) challenging ideas by taking different perspectives; and (c) contributing in reaching consensus or proposing solutions. Each student was scored 0 to 100 for each factor.

$$\text{DP of a student} = IC \times 0.3 + FC \times 0.4 + QC \times 0.3$$

(3) Paper-pencil Test

Paper-pencil tests consisted of 40% multiple choice items and 60% open-ended assessment items. The multiple choice items were intended to assess whether the students could correlate the acquired scientific knowledge with the real life; the open-ended items requesting concise answers were intended to assess the abilities as shown in Appendix 1.

7. Scaffolding

The students constructed STS literacy through activities under the researcher's scaffolded instruction: (Scaffold 1) elements of STS literacy; (Scaffold 2) scenarios and vignettes with paradoxes and challenging questions; (Scaffold 3) support from peer students in the form of cooperative learning; (Scaffold 4) questions used to elicit constructive learning to achieve the learning goals and dimensions; and (Scaffold 5) assessments of the instructors and their peers. Scaffoldings were provided only when necessary, with more in the beginning and fading slowly to build students' confidence in their abilities in constructivist learning.

8. Instructional and Assessment Procedures

The activity proceeded as follows.

First step (class-sharing and the first assessment for open-ended thinking): Scenarios were presented to the students to scaffold their open-ended thinking, encouraging them to propose their own views on issue. This is a brain-storming activity to motivate interest and promote the issue awareness. They were instructed to take time to: (a) reflect on what they had heard and seen and, (b) describe and explain their thoughts as completely as possible. Participant responses ranged in length from half to one-and-half pages, hand written. The responses were collected, copied, and scored. Then a paper-pencil test was conducted.

Second step (small group learning): Students were encouraged to form small groups of their own choice, collect, organize, and discuss information on ozone depletion to promote understanding on the issue.

Third step (class sharing): The students discussed chloroflurocarbons (CFC) in relation to its chemical properties, applications, positive and negative effects on the human life. This activity encourage students to extend and refine knowledge.

Fourth step (class sharing): Students engaged in role playing and debating to solve social issues using science and technological methods. The roles were consumers, scientists, manufacturers, environment protection administration, and health department. The problem is what we should do about CFC. These activities were to introduce the students into deeper, open-ended thinking encouraging imagination and creativity leading to blueprints of appropriate strategies for solution. Brainstorming and peer learning expanded their knowledge to domains other than chemistry. They further discussed their social duty and responsibility, establishing social as well as world views.

Fifth step (the second assessment and the paper-pencil test): The written responses in the first step were returned to them. They were then asked to use descriptive statements or STS maps to reflect their open-ended thinking on the issue (the second assessment). Then a paper-pencil test was conducted.

Results and Discussion

The results of assessing learning achievement in ozone depletion STS activities are summarized below.

1. Results of assessing levels of thinking

The students were encouraged to write down as much as possible what they heard, saw, or thought about ozone depletion, so that their overall views and extent of understanding could be assessed. Their levels of cognitive complexity in open-ended thinking were scored with McDaniel's five-point scale. The assessments on open-ended thinking revealed the levels of thinking, problem-solving, creativity, and personal, social, and global values/ethics. The comparison of their writings in the beginning and the end of activities revealed the changes in view points and abilities as the result of the activities. The activities helped students (a) link the topic with other knowledge within a discipline, with other disciplines, and with social and global problems; (b) understand the overall structural relationships among the elements in the topics, as revealed in the cognitive maps drawn by students at the end of activities; (c) understand the relationships between the already known (as revealed in the cognitive maps drawn by students at the beginning of the activities and the elements being learned; and (d) apply the process skills (such as induction, deduction, analysis and so on) already possessed to a new topic to find out similarities and differences, analyze, support, and elaborate in this new situation (the ozone depletion issue). With McDaniel's measurement thus, the STS activities were found effective .

The results of the first and the second assessments using open-ended assessment items were compared. McDaniel's levels 1 and 2 were combined into the lower level, because the learners' responses to the assessment items were mostly descriptions of the situation. Levels 3 and 4 were combined into the higher level, because the learners were able to explain how parts of the situation were interconnected (levels 3 and 4), their responses being noticeably analytic and integrated (levels 4). After the STS activity, those initially at lower levels of thinking rose to higher levels, regardless of gender.

The level increments revealed in the second assessment show that the instructional design promoted open-ended thinking and learning on the STS topic in the real life.

2. Assessment on degree of participation (DP)

In the course of the STS activities, the students comments and discussion were recorded. The average DP was 80 for the class, 76 for the males, and 85 for the females. The females surpassed the males, reflecting the fact that the females were trying harder to meet the teacher's expectation, by being more enthusiastic with a higher degree of participation in the STS activity.

3. Paper-pencil tests

The average scores in paper-pencil test conducted at the end of the STS activities were 92 (class), 91 (males), and 93 (females); the females were a little better than the males. The class average score in the paper-pencil test (92) indicates that STS activities are effective in cultivating these abilities.

4. There are strong positive correlations expressed by percentage consistencies between: degree of participation and paper-pencil test (88%); degree of participation and level of thinking (100%); paper-pencil test and level of thinking (88%); and degree of participation, paper-pencil test, and level of thinking (88%), which demonstrate satisfactory learning achievements.

These data show that after participating in the STS activities, with the aid of scaffolds, almost all students advanced to higher levels of thinking, being able to present ideas on the STS issues. These ideas show they have gained deeper understanding, problem solving ability, creativity, and appropriate social values. The advancement of learning performance can also be observed from the paper-pencil test and the open-ended thinking assessments.

5. About role playing

During the role playing in the STS activities, the students discussed the merits, the shortcomings, and the solutions in the class sharing that was employed. The findings of shortcomings, solutions, and merits are in line with the constructivist view that learning grows out of one's own experiences in authentic contexts.

Conclusion

This study shows the instructional design of the STS activities was successful. The results are summarized as follows.

(1) The STS activities maintained a high degree of student interest.

(2) Students learned from acting in authentic contexts. Having participated in the STS unit activities, they began to value highly the STS movement.

(3) Problem-centered, cooperative learning prompted students to construct high-order thinking, knowledge, skills, and views pertinent to the ozone depletion issues in the real life.

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References

Hines, J., Hungerford, H. & Tamir, A. (1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. Journal of Environmental Education, 18 (2), 1-8.

Marzano, R. J. (1992). A Different Kind of Classroom: Teaching with Dimensions of Learning. Alexandria, VA: Association for Supervision and Curriculum Development.

McDaniel, E. & Lawrence, C. (1990). Levels of cognitive complexity, An approach to the measurement of thinking. New York: Springer Verlag.

Rosenshine, B. & Meister, C. (1992). The use of scaffolds for teaching high-level cognitive strategies. Educational Leadership, April, 26-33.

Sia, A., Hungerford, H. & Tomera, A. (1986). Selected predictors of responsible environmental behavior: An analysis. Journal of Environmental Education, 17 (2), 31-40.

Waks, L. J. (1992). The Responsibility Spiral: A Curriculum Framework for STS Education. Theory into Practice, 30 (1), 13-19.

Wang, C. H. (1994). A teachers' enhancement project in Taiwan. Presented at National Science Teachers Association National Convention, Anaheim, California, March 30 - April 2.

Wang, C. H. & Tsai, H. H. (1994). Promoting open-ended thinking on the STS topic: "Detergent." Proceedings of the NSC-Part D, Vol. 3, No. 1, 37-47.

Yager, R. E. & Roy, R. (1993). STS: Most pervasive and most radical of reform approaches to science education. In R. E. Yager (Ed.), The Science, Technology, Society Movement, Vol. 7, pp. 7-13 of What Research Says to the Science Teachers. National Science Teachers Association.

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THE CHINESE REFORMS AND THE RATIONALIZATION OF ENVIRONMENTAL DISPUTE RESOLUTION[1]

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A shift from "rule by individuals" to "rule by law" has often been cited as one of the defining characteristics of modernity. Under such a conceptualization, a modern state is perceived as one in which law is "rational" in a Weberian sense--that is, codified, institutionalized, routinely enforced, and therefore, "objective". Within a rationalized legal system disputes are resolved through formal legal channels rather than through informal intervention by government officials or through mediation processes. According to Weberian logic, governments which possess a "rationalized" dispute resolution system are more efficient, and therefore superior, to those lacking such a system.

During the Deng Xiaoping era (1978-present), the Chinese state has launched numerous reforms to accelerate economic growth and "modernize" the nation. Not least of these reforms has been the transformation toward a more rationalized legal system. Serious efforts have been made to transform China from a society governed by "rule by the individual" into a society governed by "rule by law." Over the course of the 1980s and into the 1990s, China's legal and judicial systems have expanded dramatically. A vast number of laws, regulations, and statutes have been issued; legal cadres have been trained and new institutions, such as municipal legal advisory offices and village legal service stations, have been established to interface between individual plaintiffs and the judicial system (Gellhorn, 1987). In addition, legal education campaigns have been conducted to familiarize the general populace with the content of new laws and to create a legal awareness throughout society.

At the same time, China has faced increasingly severe environmental problems resulting from the country's rapid industrialization drive. Eighty percent of rivers flowing near Chinese cities are seriously polluted, chiefly from industrial wastewater (World Bank, 1992, p. ix). One hundred Chinese cities have been identified as suffering from severe water shortage (Tyler, 1993, p. 1). Atmospheric concentrations of SO^2 and particulates in Chinese cities are typically several times greater than World Health Organization standards, with China containing three of the ten most air-polluted cities in the world (Esty, et. al. forthcoming). Acid rain accounted for $ 2.8 billion in damages to farm crops, forests, and buildings in 1991 (WuDunn, 1993, p.11). In addition, heavy use of chemical pesticides and fertilizers since the early 1980s has further left poisonous residues in land and water, and this, combined with the loss of land to industrial and residential development, has reduced cultivable land, leading some to question China's future ability to feed itself (Brown, 1994).

How has the trend toward the development of a Weberian legal system in China, identified above, affected environmental protection efforts there? This paper provides a preliminarily inquiry into this question by briefly examining several issues: first, the Chinese reform context in which policy has been formulated and implemented; second, the history of environmental policy in China; third, the traditional role of law in Chinese society; and, lastly, the enforcement of China's water pollution law, citing as a case study environmental dispute-resolution experiences in Wuhan, a large industrial city with a relatively well developed judicial system. The paper concludes by reevaluating the meaning of a "rationalized" legal system with regard to its impact on environmental improvement.

The Reform Policy Climate

The Chinese reforms of the past seventeen years have initiated a multitude of changes, most notably in the economic sphere, but in the administrative and legal spheres as well. Under the reforms, there has been a marked shift in development strategy. Earlier attention to egalitarian goals in coordination with economic growth has been rejected. Instead, expansion of production and an increase in national wealth have been elevated as the primary goals of the Chinese nation-state, with the stress on individual as opposed to collective wealth attainment. The credo of the reforms is best captured by that now famous slogan, "To get rich is glorious!"

Manifestations of this shift in development strategy are seen in the fact that markets and economic incentives have been reintroduced, economic decision-making has been decentralized to municipal governments and individual enterprises, the private sector has been allowed to expand rapidly, overtaking state-owned industry as the leading contributor to GNP, and everyone--individuals, enterprises and government organs--has been told to produce for profit or help in this effort.

At the same time that dramatic changes in the economic sphere have taken place, noted changes in the administrative and legal spheres have been initiated as well. As outlined above, under the Deng Xiaoping reforms, measures have been taken to alter the role of law in Chinese society. The slogan "rely upon law to administer the country" (*yifa zhiguo*) dominated government pronouncements in the early 1980s. Throughout that decade and into the 1990s numerous laws have been written or rewritten and legal institutions expanded.

Initial efforts at rationalization of the legal system were in response to what the new regime saw as excessive displays of personal power during the late Mao years and particularly during China's turbulent Cultural Revolution period. Increasingly, however, the earlier political motivations for attention to law have given way to the promotion of law to meet the demands of market reforms for enforceable contracts and for regulation of industry. (Hence, the promulgation of a patent law and a bankruptcy law in the mid- to late-1980s and more detailed subsequent financial laws.)

Environmental Protection under the Deng Xiaoping Reforms

China's environmental protection policy which matured and expanded significantly during the reform period has also reflected, in both design and practice, the reform context in which it has developed.

Although China began to systematically address environmental questions several years before the reforms (Jahiel, 1994), since Deng Xiaoping's ascension to power in the late 1970s, attention to environmental problems has increased dramatically. This has occurred in significant part because the viability of reformers' plans for rapid economic growth depended among other things, upon the efficient use of raw materials, the availability of clean resources, and the social stability that environmental protest might endanger.

The result has been that over the course of the 1980s China's environmental protection organizational network expanded dramatically and its authority within society increased notably. By the mid- to late-1980s China had established a nation-wide organizational structure including environmental protection organs at the central, provincial, city, district, county, and, in some places, township levels. These environmental protection organs--particularly those at the city level and above--had grown tremendously in terms of number of personnel, and, in accord with the reform emphasis on technocratic leadership, were increasingly filled by scientifically and technically trained cadres. Moreover, by 1988 China had developed a series of eight policy implementation mechanisms to deal with industrial pollution problems. These had emerged from and were backed by a host of carefully delineated environmental laws, statutes and regulations which had been promulgated beginning in 1979.

Due to both its volume and substance, environmental law in China is generally regarded as one of the most comprehensive sub-branches of Chinese law (Jahiel, 1994). As of mid-1992, China had 12 national laws and over 40 regulations on the protection of natural resources and the environment. In addition, local governments had issued 127 decrees and 733 administrative regulations against pollution. Provinces and cities such as Hunan, Shandong, Beijing, Chongqing, and Wuhan had also worked out rules and procedures for the implementation of these environmental laws and regulations.

One of the key components of this body of law is its definition of measures to be taken in dealing with polluting firms. These include negative economic incentives as well as normative and coercive forms of punishment. Depending on the egregiousness of the violation and the particular circumstances, polluting firms are to be charged a fee, fined,[2] criticized, shut down, merged with another firm, forced to change lines of production, have their discharge fee payments doubled, tripled, or multiplied still further, or some combination of the above. Moreover, in the case of serious accidents (defined as those resulting in human death or serious financial losses to public or private property), responsible individuals are also to be personally punished.

In sum, China's environmental protection policy reflects the Weberian features of modern-day administration: it is hierarchically structured and institutionally articulated, composed of professional technocrats, and backed by a strong, "objective" legal code. To what degree law is actually enforced as delineated, however, depends in part on the litigious nature of a society.

The Role of Law in Chinese Society

Chinese society has generally been regarded as non-litigious (Cohen, 1966; Lubman, 1967; Utter, 1987; Fu, 1992). It is a society in which rule by individuals has traditionally dominated over rule by law (Ross, 1989, p.15). Although courts and a legal system have existed under the People's Republic of China since its founding in 1949--and before that, in Republican and dynastic times, too--until recently, the corpus of law has been severely limited in scope and breadth. Moreover, especially in civil cases, use of the courts in dispute resolution has been minimal; instead, dispute resolution in China has commonly been achieved through intervention and mediation by government or Chinese Communist Party (CCP) officials.

Although significant changes have been made to develop a rationalized legal system over the past decade and a half, throughout most of the 1980s, these many efforts had little impact on social behavior. One scholar of Chinese law, writing in the mid-1980s predicted that "[a]lthough current policy prohibits direct Party involvement in judicial matters, ingrained habits and the shortage of qualified judicial personnel mean pervasive Party involvement in legal affairs is likely to continue for some time" (Edwards, 1986). Another, concluded "China is far from becoming a litigious society. Recourse to adjudicatory processes has not been in tune with Chinese tradition or temperament" (Gellhorn, 1987, p. 15). If anything, it could be argued that China's market reforms during this time encouraged increased use of personalistic power rather than "rule by law." Arbitrary exaction of fees (*luan shoufei*) by Chinese officials became commonplace, and local government officials took to overlooking laws that impinged upon local financial interests. (Such widespread corruption was a central issue during the Tiananmen protests in 1989.)

In the environmental arena, interviews with national and local environmental protection officials in the early 1990s revealed that legally-defined punishments were rarely strictly enforced, courts were rarely if ever used for dispute resolution, and intervention or mediation continued to prevail. As of 1991, more than 95% of environmental disputes were resolved through informal mediation between the polluter, the injured party, and the local Environmental Protection Bureau (EPB). In most Chinese cities, court cases almost never arose over environmental pollution disputes; and the judicial system was almost never brought in to enforce law. Moreover, the use of personal connections (*guanxi*) to resolve legal disputes remained commonplace, and, as with other aspects of environmental policy, laws were enforced differently in different geographic regions. One division head at the National Environmental Protection Agency summed up the situation well when he said, "The phrase that best describes the present situation is 'there is law, but its unreliable!' (*'youfa buyi'*)" (Interview with author, Beijing, 1991).

By the late 1980s, however, things had begun to change. Ross, studying business law in one Chinese county in 1989, observed that "...formal dispute resolution mechanisms are acquiring increased prominence and legal significance..., albeit at low absolute numbers" (Ross, 1989, p. 18). A popular Chinese movie released about this time, "The Story of Qiu Ju," poked fun at the cumbersome nature of formal dispute resolution channels, but in doing so, it acknowledged that civil suits had become, if not frequent, at least part of the everyday knowledge base of Chinese citizens, even those in the countryside. Research in the environmental arena in the early 1990s also suggested a change in the use of formal legal channels to deal with environmental disputes.

As the legal reforms of the Deng era progressed, and as contractual relationships increasingly came to define Chinese society, environmental cases slowly began to make their way onto court dockets. These cases first appeared mostly in China's large cosmopolitan metropolises (including such places as Beijing, Guangzhou, Shanghai, and Wuhan), but environmental law cases have been tried in smaller and more remote areas as well.[3] Although still few in number,[4] these cases have been highly influential in the locations in which they have occurred and, more broadly, throughout China as a whole. In addition, much can be learned about the impact of the rationalization of the legal system from these experiences. The city of Wuhan and its experience with the "rationalization" of environmental dispute resolution provide a good case study.

Environmental Dispute Resolution in Wuhan

During the latter half of the 1980s and into the 1990s, Wuhan experienced what in Chinese terms was a spate of legal challenges to EPB rulings: five cases concerning water pollution rulings in five years. As a result of two reform factors, increased emphasis on the use of the legal system and increased emphasis on money-making, both enterprises and aggrieved citizens began to pursue grievances in court. Enterprises sought to challenge what they perceived as excessive monetary fines for pollution-related incidents; citizens sought greater compensation for pollution-related injuries suffered. Both turned to the new legal apparatus for their pecuniary interests.

Two of these five cases brought before the Wuhan courts are sufficient to demonstrate how Wuhan's rationalized legal system has been used to pursue monetary gain at the expense of the destruction of nature.[5]

The East Lake Case

The East Lake Case was one of earliest legal challenges to an Environmental Protection Bureau (EPB) ruling in China, and the second such challenge faced by the city of Wuhan. It was a complex case, involving not only the initial court case but a court appeal and a retrial. The ultimate ruling was so significant that the case gained national notoriety. The case developed as follows.

On the morning of November 27, 1986 a large number of dead fish were found floating on the ten fish ponds owned by the East Lake Fishery. Dead fish were again discovered on the morning of December 2, 1986, at which point the fishery frantically reported to a district EPB in Wuhan asking it to investigate the situation. When the EPB did so, it found that cyanide levels in the lakes were 37 times higher than national standards permitted. The Wuhan Heavy Machinery Company was found to be responsible.

On November 25, 1986, two days before the first fish kills, a worker at the Wuhan Heavy Machinery Company had discovered that the pipe to the plant's water-recycling channel had been severed, and water with high concentrations of cyanide was exiting the factory untreated. The water-recycling unit was temporarily shut down and production was halted for two days. However, facing mounting financial losses, the firm soon decided to resume production, once again releasing toxic wastewater. Within five days following the resumption of production, far more massive fish deaths were reported. It was at this point that the district EPB ordered the factory to immediately stop discharging its polluted wastewater. However, the firm waited several hours before finally closing down the pipes. Ultimately, two days later, it repaired the system, but in the meantime more cyanide was released into the fishery's ponds, and by December 4, all fish in the East Lake Fishery's ponds had died.

According to law, the firm was clearly negligent. It had failed to notify either the injured party or the EPB when the accident occurred, as required by China's 1984 Water Pollution Prevention and Control Law. It had also failed to heed EPB demands immediately, and had knowingly resumed production when the source of danger had not been brought under control.

Not surprisingly, the fishery that had incurred severe losses of fish sought retribution, and, in accord with traditional arbitration methods, requested that the district EPB mediate a compensation settlement. The EPB did so, and issued a decision fining the firm Y 10,000--the minimum fine to be assessed on a pollution-related accident according to law [*Zhonghua renmin gonghe guo shui wuran fangzhi fa* (Water Pollution Prevention and Control Law of the People's Republic of China), 1984, Article 39]. In addition, it required the firm to pay Y 83,600 for the lost fish. The EPB arrived at this sum based on the fishery's annual earnings for the previous three years.

The fishery, however, was very dissatisfied with the EPB's ruling. It claimed it had suffered far more in damages and asserted that it was due Y 223,775 in compensation, more than two and a half times the EPB's ruling. Given the new legal framework, the fishery decided to sue the EPB.

The case was tried by the Administrative Trial Court of the Wuhan Intermediate People's Court, which ruled that the EPB was correct in requiring the firm to compensate the fishery, but incorrect in its judgement of the amount of compensation. It ordered the machinery factory to compensate the fishery Y 99,454--slightly more than the EPB's original judgement.

However, the polluting firm was not satisfied and chose to contest the Intermediate People's Court ruling by appealing the case to a higher court--the provincial court. This court overturned the lower court's case on technical grounds, and required the lower court to retry the case. Ultimately, when the case was retried, the EPB's original decision regarding the amount of compensation due the fishery was upheld.

The effects of the East Lake Case on the Wuhan EPB and on the city of Wuhan in general were significant. The East Lake Case increased the Wuhan EPB's sensitivity to legal precision. For example, it made EPB officials careful when issuing rulings to distinguish between punishment decisions (*chufa jueding*) regarding fines (which, according to the court ruling, EPBs *could* make and were binding), and management decisions (*chuli jueding*) regarding compensation (which, the court had ruled, EPBs could *suggest* but were not binding). As a result, some changes in implementation procedures resulted.

The East Lake Case also led to the establishment in Wuhan in 1988 of a special Environmental Protection Court (*huanbao ting*). The Intermediate Court reasoned that, given the volume of environmental laws and the recent complicated cases that had developed in Wuhan, it was necessary to have a body of experts to interpret law. The existence of this special legal branch in Wuhan has acted as a further encouragement for all parties to use the judicial system both to enforce rulings and to challenge them.

The Administrative Litigation Law[6]

The rationalization of China's legal system reached new levels shortly after the resolution of the East Lake Case with the promulgation on April 4, 1989, of the Administrative Litigation Law (ALL). Chapter 1, Article 1 of the law defines its purpose as formulated "...to protect the legal rights of citizens, legal persons and other groups, by assuring that administrative organizations are exercising their functions and powers in accord with the law" [*Zhonghua renmin gongheguo xingzheng susong fa* (The Administrative Litigation Law of the People's Republic of China), 1989, Chapter 1, Article 1]. This law provides people the right to sue an administrative organ when they feel that the government unit or its officials have taken administrative actions in violation of the unit's administrative powers. Although two such suits had already occurred in the Wuhan EPB's history, there had been no legal foundation for these actions. The ALL legitimized such action and encouraged and publicized it, dramatically widening both the scope of such cases and their significance.

Following the promulgation of the Administrative Litigation Law, a nation-wide effort was made to educate all government cadres about this law. As a result, throughout Wuhan, news of the ALL spread quickly--and very quickly brought forth several more challenges to EPB rulings.

The Case of the Yangtze River Chemical Factory

The Case of the Yangtze River Chemical Factory was the second case to arise immediately after the promulgation of the Administrative Litigation Law. This case involved a Freon plant on the outskirts of Wuhan. The factory had a history of disputes with neighboring peasants over water pollution issues.

To address the firm's solid waste problem, the local Environmental Protection Bureau had instructed the factory to mix limestone with its hydrofluoric acid and not to dispose the untreated hydrofluoric acid directly into nearby streams. However, the company had routinely ignored the EPB's advice, depositing its solid waste near its wastewater pool. In June 1990 when the district EPB conducted its annual spot-check of the plant, local peasants informed EPB officials that their vegetable crops had been ruined, fish were dying, and cattle were seriously injured. Apparently, the wall in the factory housing the wastewater pool had developed a hole. Hydrofluoric acid from the factory had seeped into the wastewater, polluting it, and this polluted wastewater was running into the gully which led to a nearby stream. The stream was used by local peasants to draw water for crop irrigation; cattle waded in it and fish swam in it. As a result of the pollution of this stream, crops were ruined, fish were killed, and cattle were seriously injured, their flesh eaten away by the hydrofluoric acid.

When district EPB officials returned to the site of the accident to inspect the situation, they took photos of the scene and tested the acidity of the water, which they found to be high. They reported their findings to the factory on June 14, 1990, and told the factory representatives to quickly plug up the leak and deal with the hydrofluoric acid problem. But the factory continued to ignore EPB mandates.

Some time later, the village Communist Party secretary and other village leaders were brought to look into the matter. These officials ordered the factory to remedy the problem immediately, at which point the factory finally took action. Thus, traditional means of exerting the personal power of the local leadership worked to achieve action where the EPB's limited administrative authority had failed.

On October 29 1990, the district EPB followed up the case by issuing an administrative punishment decision to the firm, ruling that the company had been too lax with environmental protection measures, had not listened to EPB demands on several occasions, and, as a result, had caused serious financial losses. (Note that the EPB's own ruling emphasized the financial losses and not losses to nature or to animal life.) The district EPB fined the firm Y 5,000.

However, the company was very powerful in the local economy, being the sole producer of Freon for the entire southwest region of China. As a result, it chose to challenge the EPB's ruling by suing the EPB and pursuing the issue in court.

The district EPB, overwhelmed by the turn of events, requested help from the Wuhan municipal EPB. When the municipal EPB began to investigate the case it discovered that the district EPB had conducted its affairs too loosely. District EPB officials had not brought the proper on-site investigation form (*xianchang jiancha biao*) to the factory when making their inspections. Consequently, although the EPB had a record of the investigation on a scratch pad, there was no formal record of the events on that day signed by the firm. In addition, the photographs that the EPB had taken as evidence were not dated, and the EPB had not taken pictures of the destroyed crops. EPB officials had taken photographs of the pile of hydrofluoric acid, but as the defendant later remarked, "Who was to say it wasn't just snow?" Most seriously, however, the EPB had violated Article 32 of the Regulations for Implementation of the Water Pollution Prevention and Control Law (*Shui wuran fangzhi fa shishi xizi*), which required that fines for such accidents be set at between Y 10,000 and Y 100,000. The district EPB had taken into consideration the economic difficulties of the firm and had only charged Y 5,000, committing a grave procedural mistake. This meant that the court could overturn the EPB's administrative punishment as unlawful. The Municipal EPB was quite concerned about this.

Ultimately, the EPB did not have to worry about this mistake. Although the lawyer for the Yangtze River Chemical Factory realized the district EPB's legal mistake, he also recognized that if he raised the issue, the company could be fined much more than it had been. Instead he tried to argue in defense of the factory that the accident was "an act of heaven" due to severe storms and flooding, and, therefore, that the factory should not be fined. However, the lawyer for the EPB had obtained proof from the Hubei Provincial Applied Meteorology Institute verifying that, although it had rained at the time of the accident, there had been no unusually heavy storm as the prosecuting party contended. This testimony severely weakened the plaintiff's claims. In the end, on December 27 1990, the case was absolved when the Freon factory withdrew its charges during a break in the trial because it realized that it had no basis for its claims.

Although the Yangtze River Chemical Factory Case ended with relative ease in favor of the EPB, it too had a profound effect on EPB behavior. It taught Wuhan EPB officials to make sure punishments were determined within legally stipulated boundaries; it established set procedures for conducting investigations; it encouraged routinization of law enforcement through use of forms; and it familiarized Wuhan enterprises with what to expect should they be responsible for creating environmental accidents. In doing so, it helped institutionalize environmental policy enforcement in Wuhan.

Conclusion

The Wuhan EPB's experience with the preceding cases demonstrate that the "rationalization" of the legal system in China has had some beneficial impact on environmental protection efforts in parts of China but that the impact has not been solely the positive one predicted by the Weberian model.

In the city of Wuhan, the five legal challenges to EPB water pollution rulings--including the two challenges reviewed above--resulted in a significant institutionalization of environmental law enforcement. In response to its encounters with the legal system, the Wuhan municipal EPB introduced various methods to formalize policy implementation:

- it began issuing forms to local EPBs and requiring their use;
- it demanded that local EPBs refer specifically to the precise article of law that a firm had violated when writing up administrative punishment decisions;
- it established formal written procedures for addressing challenges to EPB rulings;

- and it took numerous steps to improve its legal educational efforts by distributing reports of each legal case to all local enterprises and EPBs, publishing a reference book of national and local environmental protection laws and regulations for distribution to EPB officials and the general public, and holding legal training classes for EPB and other officials.

In response, district EPB officials, too, began altering their behavior: when disputes arose, they now reported incidents to the city EPB before issuing a ruling; they were much more precise with data collection; and some district EPBs even purchased video equipment to scientifically record information regarding environmental disputes for later use in court cases.

In sum, by the early 1990s increased use of the legal system in environmental dispute resolution cases had led to numerous institutional and behavioral changes and to a greater routinization of legal procedures in Wuhan. Interviews with officials in Beijing suggest that the situation was the same in other cities where EPBs had faced legal challenges to their rulings.

These many changes in administrative procedure may appear inconsequential in terms of improving environmental quality. In fact, however, the routinization of enforcement procedures and efforts to educate various government and enterprise officials create conditions that help to legitimize EPB authority to implement policy, and, in so doing, may indeed advance environmental protection efforts. In addition, the routinized implementation of law may help curb lax enforcement of environmental policy that sometimes accompanies personal relationships associated with "rule by the individual."

Nevertheless, in other ways, careful examination of the Chinese judicial experience with regard to enforcement of environmental law calls into question the accepted superiority of a "rationalized" legal system. What this paper has suggested is that although a rationalized legal system may have the benefits of assuring routine enforcement of law, it may also yield the negative consequence of hindering the implementation of policy by creating an accepted tool--a tool perceived as more "objective" than all others--by which to challenge policy enforcement.

In the cases explored here and in other cases from the city of Wuhan, it was the strong interest in monetary concerns that encouraged enterprise owners and aggrieved citizens alike to challenge Environmental Protection Bureau rulings in court. In the East Lake Case, the peasants who owned the fish ponds were not gravely concerned with environmental quality but simply wanted greater financial compensation. In the Yangtze River Chemical Factory Case, the factory simply did not want to pay the fine, and thought it could avoid doing so because of its power in the local economy. The enterprise was extremely resistant to acknowledging its responsibility for what was a serious environmental crime that included loss of animal life and crops--and serious threats to human health. Instead, it focused simply on monetary concerns.

The findings in the Chinese case are perhaps short of startling. What is revealed by this case, however, is how intricately linked law is to the ideology of a particular political system, in this case, the market ideology of the reform setting. Given China's reform climate and its emphasis on money-making, as the power of the EPB to enforce law has risen, so too has the interest in challenging the assertions of this power when such assertions have monetary implications. As one EPB official put it when talking about the rise in the number of disputes brought to EPB attention over the past two decades,

> The public's recognition of the [environmental problem] increases each year and so do the number of letters the EPB receives. ...The reason that people pursue this so much now is partly due to increases in environmental consciousness. [But] its also due to their economic interests in being financially compensated. (Interview with author, Beijing, 1992)

Although common wisdom suggests that a rationalized legal system in the Weberian tradition is a superior legal system and a true sign of modernity, this paper gives cause to question the presumed efficacy of such a system with regard to environmental protection. It suggests that even rational legal systems are molded by the ideological climate in which they are developed and in which they operate. Even when law is designed for the purpose of environmental protection, enforcement through legal channels cannot automatically guarantee the actualization of the intent of a given law. Legal reform in China is consciously advanced to support the dominant norms and values of a marketizing society. Enforcement of these laws, thus, ultimately reflects these norms and values. Law is subject to interpretation, not to mention manipulation. As a result, even the best-intentioned laws are subject to bias through the process of enforcement. The bias in China today is above all on the side of economic growth and profit, and, at best, secondarily on the side of environmental protection. The cases and trends noted above suggest that further rationalization of China's legal system within the current reform context may have some salutary effect, but that law will not of itself provide a reliable means to address the country's worsening pollution crisis.

1 Information for this paper is based largely on field research conducted in China in 1991 and 1992. Original court documents concerning the cases discussed herewith were examined for this study and environmental protection officials in Wuhan, Beijing, and two other cities were interviewed. This research was supported by a grant from the Committee on Scholarly Communications with the People's Republic of China, for which I am very grateful.

2 The legal distinction between a fine and a fee is that fines are charged as punishments, whereas fees are charged to purchase rights.

3 For example, in July 1992 a peasant in Qing Xiang, a suburb of Guiyang in the interior province of Guizhou, won a suit against a factory and a technical school. Water pollutants discharged by the Light Industry Technical School and the Guiyang Building Material Plant had caused the death of hatchlings in the peasant's fishery. See, "First Legal Victory Under New Environmental Laws Reported" *Op. Cit.*, p. 12. Note however, that the title indicating this as the first victory is misleading as the Wuhan cases discussed in this article attest.

4 Exactly how many environmental cases have been brought to court in China is impossible to assess. The Chinese legal system is not a case law system. Neither national legal compendia nor provincial legal compendia exist. Even Wuhan University's Center for Environmental Law, the national institute for the study of environmental law in China, does not house a comprehensive collection of environmental law cases in China.

A couple of books have been published containing compendia of dispute resolution situations, a few of which have involved court trials, but most of which involve dispute mediation and administrative settlements. For case studies of such dispute resolutions see *Huanjing jiufen anli* (*Environmental Dispute Cases*), Zhao Yongkang, ed., (Beijing: China Environmental Science Press), 1989, and *Huanjing Jiufen anjian shili* (*Examples of Environmental Dispute Cases*), Zeng Zhaodu and Sun Xiangming, eds., (Wuhan: Wuhan University Publishing House), 1989.

5 Information for these two cases was drawn from interviews with Environmental Protection Bureau officials in Wuhan, from a review of court documents, and from the following additional sources: *Wuhan huanjing zhi* (*The Wuhan Environmental Compendium*), (Beijing: China Environmental Science Press), 1988, p. 159; "*Wuchang qu huanjing baohu ju wenjian, Wuchang huanjing guanli* [1987] No. 1" (Wuchang District Environmental Protection Bureau Document, Wuchang Environmental Management [1987] No. 1".

6 For an excellent review article on the Administrative Litigation Law see Susan Finder, "Like Throwing an Egg Against a Stone?: Administrative Litigation in the People's Republic of China," *Journal of Chinese Law*, Vol. 3, Summer, 1989, No. 1, (Center for Chinese Legal Studies, Columbia University School of Law). For a copy of the Law, see

"*Zhonghua renmin gongheguo xingzheng susong fa*" ("The Administrative Litigation Law of the People's Republic of China"), in Huanjing baohu fagui huibian (*The 1988-89 Compendium of Environmental Protection Laws and Regulations*), edited by the Shanghai Municipal Environmental Protection Bureau, 1990, pp. 108-122.

References

Brown, Lester. "Who Will Feed China?" *World Watch*, September/October, 1994.

Cohen, Jerome. "Chinese Mediation on the Eve of Modernization," *California Law Journal*, Volume 54, 1966.

Edwards, R. Randle. "Civil and Social Rights: Theory and Practice in Chinese Law Today," in *Human Rights in Contemporary China*, (New York: Columbia University Press, 1986).

Esty, Daniel, Therese Feng and Daniel Rosen. *Powering China*, (forthcoming).

Finder, Susan. "Like Throwing an Egg Against a Stone?: Administrative Litigation in the People's Republic of China," *Journal of Chinese Law*, Vol. 3, Summer, 1989, No. 1, (Center for Chinese Legal Studies, Columbia University School of Law).

Fu, Hualing. "Understanding People's Mediation in Post-Mao China," *Journal of Chinese Law*, Volume 6, Fall 1992, No. 2.

Gellhorn, Walter. "China's Quest for Legal Modernity," *Journal of Chinese Law*, Volume 1, Spring 1987, No. 1.

Jahiel, Abigail R. *Policy Implementation through Organizational Learning: The Case of Water Pollution Control in China's Reforming Socialist System*, (University of Michigan, Ph.D. dissertation, 1994).

Lubman, Stanley. "Mao and Mediation: Politics and Dispute Resolution in Communist China," *California Law Review*, Volume 55, 1967.

Ross, Lester. "The Changing Profile of Dispute Resolution in Rural China: the Case of Zouping County, Shandong," in *Stanford Journal of International Law*, Volume 26, No. 1, Fall, 1989.

Tyler, Patrick. "China Lacks Water to Meet Its Mighty Thirst," *The New York Times*, November 7, 1993, p. 1.

Utter, Robert F. "Dispute Resolution in China," *Washington Law Review*, 1987.

World Bank. *China Environmental Strategy Paper*, (Washington, D.C.: World Bank, Report No. 9669-CHA), 1992.

"*Zhonghua renmin gongheguo shui wuran fangzhi fa*" ("The Water Pollution Prevention and Control Law of the People's Republic of China") in Huanjing baohu fagui huibian (*The 1988-89 Compendium of Environmental Protection Laws and Regulations*), edited by the Shanghai Municipal Environmental Protection Bureau, 1990.

"*Zhonghua renmin gongheguo shui wuran fangzhi fa shishi xize*" ("The Regulations for Implementation of the Water Pollution Prevention and Control Law in the People's Republic of China") in Huanjing baohu fagui huibian (*The 1988-89 Compendium of Environmental Protection Laws and Regulations*), edited by the Shanghai Municipal Environmental Protection Bureau, 1990.

"*Zhonghua renmin gongheguo xingzheng susong fa*" ("The Administrative Litigation Law of the People's Republic of China"), in Huanjing baohu fagui huibian (*The 1988-89 Compendium of Environmental Protection Laws and Regulations*), edited by the Shanghai Municipal Environmental Protection Bureau, 1990.

PHYSICS: CONCEPTS AND CONNECTIONS

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Physics: Concepts and Connections (PCC) by Art Hobson, published in 1995 by Prentice-Hall Inc., is an STS-friendly physics textbook with an interdisciplinary flavor. Written for nonscientists, it approaches physics as a human endeavor, in philosophical and social context. Not a watered-down version of the standard technical texts, PCC is a true liberal-arts physics text that connects physics with its cultural aspects.

General Description

The book has significant societal content, which is unusual in physics textbooks. There are in-depth discussions of ozone depletion, global warming, technological risk, energy resources, exponential growth, nuclear power, nuclear weapons, alternative energy, alternative transportation, scientific methodology, the role of science in our culture, and more. These societal issues are treated as applications of physics and as examples of scientific methodology.

Fully 50% of PCC is devoted to modern physics, giving students a more extensive look at relativity, quantum physics, nuclear physics, and high-energy physics. These topics will motivate students and stimulate discussion of related philosophical questions.

To provide depth and a more coherent framework, PCC is structured around four unifying themes: (1) scientific methodology--how we know what we know in science; (2) comparisons and contrasts between Newtonian and contemporary physics; (3) the social relevance of physics; (4) energy as a unifying concept for understanding and analysing all physical processes.

The book aims at a quantitative level that is appropriate for non-scientists: neither too much math nor too little. PCC is quantitative but non-algebraic. It emphasizes the ability to use numbers, interpret graphs, understand proportionalities, think probabilistically, and make numerical estimates, rather than less important algebra-based physics problems. This approach builds relevant quantitative skills without discouraging non-science students.

The book has numerous pedagogical aids. The writing is clear and direct, avoiding unnecessary jargon. Quotations in the margins by physicists, philosophers, and others add perspective, interest, history, and humor. In-text dialogue questions, with answers at the bottom of the page, assist active learning and confidence. Frequent "How do we know" subsections emphasize scientific methodology and observational evidence. "Making estimates" subsections illustrate the use of estimates to work out rough answers to difficult questions. Footnotes provide additional depth without burdening the main body of the text with excessive detail. End-of-chapter material includes a summary of ideas and terms, review questions, home projects, discussion questions, and exercises with answers provided at the end of the book.

Most previous physics textbooks for nonscientists are "watered down" (i.e., less mathematical) versions of the algebra/calculus-based texts for scientists. These texts contain no philosophy, and no societal topics, i.e., they contain none of the context of physics. They are primarily Newtonian with only 20% devoted to modern topics. PCC on the other hand, follows the recommendations of the American Association for the Advancement of Science (AAAS), the National Science Board, and the American Physical Society (APS) to present physics *as a liberal-art* as defined for example by AAAS's *Project 2061*, emphasizing scientific methodlogy, cultural topics, and societal topics. PCC also follows the recommendation of the APS Introductory University Physics Project to include more modern physics, while omitting many less important details.

The book comes with an extensive Instructor's Manual to assist teachers in using this new kind of physics text, particularly in teaching the more interdisciplinary topics. Besides the standard items found in most instructor's manuals (exercise answers and suggested exam questions), the Instructor's Manual begins with 15 pages of general teaching suggestions and an annotated list of general references, then for each chapter there are several pages of general notes and section-by-section classroom teaching notes, plus an annotated list of references on that chapter's topics so that teachers can obtain additional background. The notes and references provide additional information and teaching ideas on all topics but especially for the more interdisciplinary topics such as global warming, scientific methodology, extraterrestrial life, philosophical implications, etc. Instructors are encouraged to ask for the Instructor's Manual when ordering the textbook.

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From the Preface

This is a liberal-arts physics textbook, for non-science college students. Its central premise is that nonscientists deserve a true *liberal-arts* physics course. Thus, this is not a watered-down version of the standard technical introductory physics textbooks for scientists. Far from being a simplified version of anything, this book is designed for a course that has a cultural sophistication not found in more technical courses. It is a cultural, rather than a technical, physics textbook. It presents physics as a human endeavor in its full philosophical and social context.

Many organizations have recommended new approaches to science education and science literacy. The features in this book that reflect these recommendations include:

Scientific literacy. This book addresses the values, philosophical meaning, and social impact of science, and stresses the methods of science.

Modern physics. Fully half of this book is devoted to such post-Newtonian topics as relativity, quantum theory, nuclear physics, and high-energy physics.

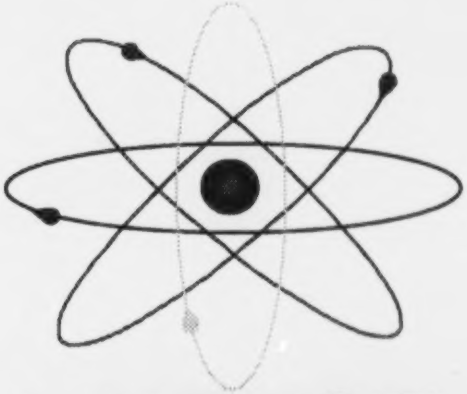
Societal connections. This book applies the ideas of physics to such socially relevant topics as ozone depletion, global warming, technological risk, energy resources, nuclear power, and nuclear weapons.

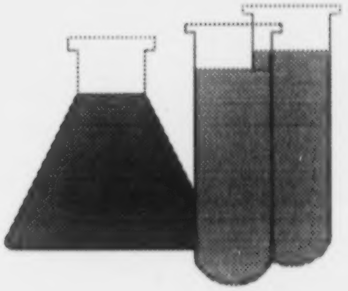
Appropriate quantitative skills. Non-scientists should become *numerate* as well as literate in science. The abilities to interpret graphs, to think probabilistically, and to make rough numerical estimates are important for non-scientists, while traditional algebra-based physics problems are less important. Just as one can appreciate a painting without being able to paint, one can appreciate the power and beauty of a scientific idea without solving equations. Thus, this book is quantitative but non-algebraic.

Less is more. While presenting most of the great ideas of physics, this book omits many narrower topics and applications normally "covered" in introductory courses.

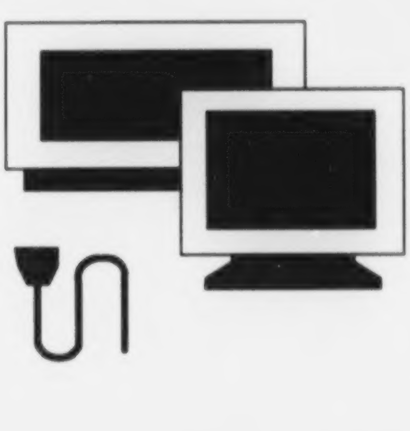
Unifying themes. Four story lines recur throughout the book: (1) how we know what we know in science; (2) comparisons and contrasts between Newtonian and contemporary physics; (3) the social context of physics; (4) and the unifying concept of energy.

One justification for communicating these ideas to non-scientists is simply that, as a matter of general principle, educated people should understand science's view of the modern world. But there is a more pressing, practical reason: In an age when science and technology are driving rapid cultural and physical changes on Earth, it is imperative that non-scientists contribute their understanding and their perspective to helping us figure out where we are going and where we should go. Today, science is far too important to be left to the scientists. I have written this book for you, the teachers, poets, politicians, historians, business people, journalists, and others who must help us find a rational and humane path through a time of rapid change and powerful technologies. We need your perspective, and your informed leadership.





SCIENCE, TECHNOLOGY AND SOCIETY IN K-12 EDUCATION



AVAILABLE, READY TO EXPLORE!

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For the past two years a team of teachers have been working on a curriculum that utilizes the neighborhood park, the schoolyard, community public areas and a vacant lot as sources of outdoor environmental projects and/or science explorations geared to primary children's needs, interests, and their cognitive/emotional development.

"Why," you may ask, "do we single out these particular avenues to pursue?"

A simple explanation is that these sites are available. Science is here, there, all around us - Hug a tree, scratch a rock, lift up a dead stump, trample through the leaves, follow an ant trail, smell the fragrance of the cherry blossoms in bloom, collect acorns, lie on the grass, listen to the cricket, whistle like a bird, smell the wet soil, feel the rain - What better way to engage all of the children's senses? The children construct their own knowledge and interpret how and why things happen. They interact with the environment in an unhurried fashion with the adult taking cues from them. The adult needs only to provide the materials and the time to make explorations and investigations happen. The adult is the observer of the children.

Explorations can be duplicated easily during changes of seasons, time of the day, during climate and weather shifts. A Ten Minute Walk (see references) or a 30 minute exploration can elicit many responses from the children. What is required is a different mind set on the part of the adult. The adult must be less intrusive, more of the guide who assists the children in their quest for knowledge and who engages them through their natural curiosity.

Outdoor projects also involve studying man-made elements (playgrounds) and how these elements interact with the children and the environment. One could use the environment as a laboratory and integrate all the disciplines.

Useful ideas:

- Life under rocks and in soil
- Tree stumps
- Garden sites
- Bird Nests

- Native Vegetation
- Resident and migratory bird species
- Trees
- Animals - ants, earthworms
- Shadows
- Who makes a home here

The above ideas, certainly substantial and "correct", are what I refer to as the inclusive common themes which permeate outdoor explorations. What I wish to suggest is that there is a whole world of neglected critical thinking problem-solving ideas that can infuse outdoor explorations - activities suitable for children as young as four years old.

Scenario #1:

On a visit to the Park, young children have their cardboard recycled clipboards with them. They are surveying items which they thought they woud find in the Park.

We discovered: (Sample list)

Trees	Yes	No
Pigeons	Yes	No

However, the children are amazed to discover all the debris left by adults. Discussions and astute questions elicit responses from the children such as:

People make the trash... not animals... not enough trash cans... not enough signs telling people not to litter... need policemen here in the park to give tickets like parking tickets... people should not be allowed to bring food to the park (groans from most of the children). Four and five year olds are holding their own (albeit informal) brain-storming activity re: why is there trash in our park?

Investigations can go on, including surveys and Park Supervisors invited to speak to children. Of course children's work and comments are on-going, recorded and documented on experience charts or other media.

Scenario #2:

An adult has read "Hansel and Gretel" to the group. One precocious child wonders if Hansel and Gretel's plan would work - wouldn't the birds and other hungry animals eat the bread crumbs that they had left for a trail? The children formulate their own plan to test the idea. They decide to save the crumbs of some Graham crackers from snack. They will break them up into bits - each child carries a bag of Graham cracker crumbs. The children visit the park- plan the trail - (Measurement skills, use of meter stick, mapping skills, use of markers, design skills.) Now we need to recognize the site. Children ask, "Are we allowed to make some signs and place them in the dirt?" This becomes a lesson in local policy making. Whom do we write to for permission to add signs to the Park? The teacher makes mental notes to also discuss soil and dirt with the children. The next day they revisit the trail to see if their crumbs have disappeared.

The children brainstorm:

- Did animals eat the crumbs?
- Did Park Personnel sweep the trail clean?
- Did a wind blow the crumbs away?

They are learning about variables and setting up controls and proper experiments. They decide to replicate the experiment by doing it one morning, then revisiting the site 2 hours later. The experiments go on. They invite a scientist to visit the classroom to answer the question of the mystery of the disappearing crumbs.

Scenario #3:

The children utilize the local playground in their community park. They notice broken swings, they get splinters from the sides, they skin their knees on the hard concrete. They have to wait too long for turns on inadequate play equipment, which is of sub-standard type. Back in the classroom, the teacher facilitates an open-ended discussion on playgrounds. The children decide to list what kinds of activities they like to do outdoors such as:

- Swinging on ropes
- Climbing equipment
- Going through tunnels, obstacle courses
- Swinging on tires
- Falling on soft surfaces
- Riding bicycles and tricycles
- Playing specific ball games
- Sailing toy boats
- Making sand castles
- Having picnics
- Rolling down hills
- Pitching horseshoes
- Cooling off in the sprinkler
- Miniature play house
- Sledding in the winter
- Ice-skating, roller-skating
- Building with blocks and/or other equipment

Eventually the children design their own dream playground. They construct a miniature model of one in the classroom. They invite architects and parents into their classroom.The children and their parents survey and petition the Parks Department for changes in playgrounds. The result is the formulation of a Grassroots Parks Committee dedicated to changing playgrounds. Parents, children and school personnel collect enough signatures to persuade the Parks Council to renovate one playground as an experiment in progress. They utilize the children's ideas and make use of recycled materials, especially old rubber tires as swinging equipment and for floor surface. The children, in effect, become the catalyst for change and become empowered through their actions. Young children are capable of problem solving:

- Are there enough trash cans around?
- Why is playground equipment broken?
- Who takes care of weeding and planting?
- Should parks be free?
- What is a park?
- Can we design a park for children your age?

- Is a park a living thing?
- Why are some trees dead?
- Do squirrels find their buried nuts?
- Are there rats in this park?
- Was this park always here?
- What animals come out at night?

As you can see, a park or a vacant lot becomes many things to many people. Of course we want the children to become knowledgable about the local flora and fauna, but we also want to move them along the continuum - they must become proficient explorers, and risk takers, they must discover the skills and tools of scientific thinking and critical analysis.

Attached are various sheets demonstrating a myriad of activities and sample lessons for teachers to replicate and supplement. Have fun -There is a wealth of information hidden in a vacant lot, in a park, or in a community playground.

PRIMARY REFERENCES

Barbara Sprung, Merle Froschl, and Patricia B. Campbell, **What Will Happen If... Young Children and the Scientific Method** (Educational Equity Concepts, Inc., distributed by Gryphon House, Inc., 3706 Otis Street, P.O. Box 275, Mt. Rainer, MD, 20712, 195). ISBN 0-931-62902-0

Margaret McIntyre, **Early Childhood and Science** (NSTA, Arlington, VA, 1987). ISBN 0873551-029-3

Mary Appelhof, **Worms Eat My Garbage** (Flowerfiield Enterprises, 100332 Shaver road, Kalamazoo, Michigan 49002).

John Roeder (ed.) , "**The Teachers Clearinghouse for Science and Technology Education Newsletter" (**The Day School, 1 West 88 Street, New York, N.Y. 10024).

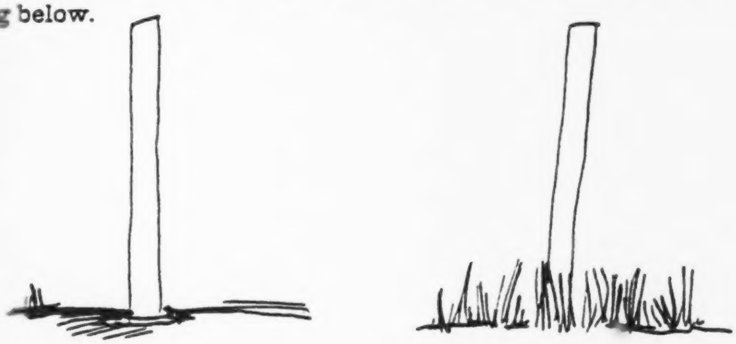
Helen Ross Russell, **Ten Minute Field Trips** (J.G. Ferguson Company 1991) 176 pages. $16.95.

National Audubon Society, (950 Third Avenue, New York, N.Y. 10017).

What Happens When It Rains?

I. Before a rainstorm, put one stick in a patch of bare soil and another one in a patch of grass.

After the rain stops, measure how high the mud splashed on each stick. Show the height on the drawing below.



Where did the mud splatter higher? ____bare soil ____grassy patch

II. Walk outside the school after a heavy rain. Check where you find puddles.

Check how big the puddles are.

	BIG PUDDLE	SMALL PUDDLES	NO PUDDLES
On the grass			
On a bare patch of lawn			
Under street trees			
On the sidewalk			
In the gutters near the curbs			
In the middle of the street			

III. Do you see any little "rivers" running down driveways or lawns? ____yes ____no

If so, are they clear? ____ muddy? ____

Collect some of the muddy water. Let it stand. What happens?

Does mud settle out? ____yes ____no

IV. If there is a sloping lawn near your school, are there bare patches on it?

____yes ____no Gullies? ____yes ____no

Are the bare patches smooth and even? ____ uneven and like ruts? ____

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V. On a dry day, look to see if there are any pieces of soil lying on the sidewalk or in the gutter. Are all the little pieces the same size? ____yes ____no

Do you find little pieces of the same size together or scattered?

Together ____ Scattered ____

Draw a picture showing how these particles are scattered.

VI. Does this scattering tell you which way the water was flowing?

How Big Are Raindrops?

Purpose Students preserve raindrops in raindrop collectors. They learn some factors affecting raindrop size and measure the sizes of raindrops. They also examine the affects of the amount of rain on plant life.

Materials

For each raindrop collector:

1 shoe box lid or small shallow cake pan
flour to fill the box lid or pan
flour sifter or strainer
1 sheet of dark construction paper
stiff cardboard or several layers of newspaper to cover the lid or pan

centimeter rulers
pencils

Background

As the tiny droplets that form a cloud accumulate, they combine and grow until they become so heavy that they fall. The falling droplets collect more droplets as they descend through the cloud. The droplets fall to the ground as raindrops. A raindrop's size depends on how many and what size droplets it has collected. Denser clouds can produce larger raindrops than less dense clouds because there are more droplets available to be picked up. A raindrop's speed depends on its size; larger drops fall faster than smaller drops.

Raindrops falling from higher clouds are often smaller than raindrops falling from lower clouds. This is because large droplets break up into smaller ones when they reach 29 kph (18 mph). Droplets from higher clouds are more likely to accelerate to this breaking-up speed.

How much water reaches the ground depends on the size and number of raindrops that fall and also on obstacles below the clouds. Open land under the thickest parts of a rain cloud will receive the most water. Land sheltered by such things as trees, shrubs, and buildings will receive less or no water.

Doing the Activity

1. Before it rains, determine where to place the raindrop collectors. Good sites are open areas, under trees near the trunks and also below the tips of branches, near buildings, and under bushes. Decide how many sites you want to use, and then divide the class into groups, one group to a site.

2. Give each group materials for a collector. Instruct each group to fill a box lid to the top with sifted flour. Students should gently level off the flour with the edge, not the flat side, of the ruler. The flour should be as uniformly dense as possible, so they should take care not to compact the flour with the ruler. Have the students cover the pans with cardboard.

3. During the next rainfall, each group should take its collector outside to its preselected location, jarring the flour as little as possible. Students should note the position of the rain cloud and what it looks like. Have them uncover the collectors for five seconds and then quickly replace the cardboard.

4. Return the raindrop collectors to the classroom. Begin a class data table.

Place	What the cloud looked like	Number of drops	Size of drops

Allow the raindrop pellets to harden overnight. Have the students remove the pellets from each collector and glue them onto sheets of dark construction paper. They can record on the paper the location where the drops were collected and measure and record the diameters of the raindrop pellets. Complete the class data table.

Wrapping Up Discuss the results of the activity. Did all the boxes have about the same number of drops? Which ones had the most? The least? Which pans had the smallest drops? The largest drops? Have students suggest reasons for their findings. What kinds of plants grew in each area? Does the number of raindrops have anything to do with the plants observed in that location?

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BIBLIOGRAPHY

You and Your Neighborhood

POETRY

Hopkins, Lee, ed. **I Think I Saw a Snail, Young Poems for City Seasons.** Crown, 1969.
Livingston, Myra Cohn. **Wide Awake and Other Poems.** Harcourt, Brace, and Company, 1959.
O'Neill, Mary. **Hailstones and Halibut Bones.** Doubleday, 1961.
Phoebe. **Noses Are for Roses.** McGraw-Hill, 1960.

PROSE

Lowery, Lawrence and Carr, Albert. **Quiet as a Butterfly.** Holt Rinehart and Winston, 1969.
Radlauer, Edward and Ruth. **What is a Community.** Elk Grove, 1967.
Selsam, Millicent. **You and the World Around You.** Doubleday, 1963.

Other Living Things

POETRY

Aiken, Conrad. **Cats and Bats and Things with Wings.** Atheneum, 1965.
Fisher, Aileen. **Cricket in a Thicket.** Charles Scribner's, 1963.

SONGS

Seeger, Ruth. **Animal Folk Songs for Children.** Doubleday, 1950.

PROSE

Adler, Irving and Ruth. **Insects and Plants.** John Day, 1962.
Allen, Gertrude. **Everyday Insects.** Houghton Mifflin, 1963.
"Animal Kingdom," N.Y. Zoological Society, Bronx.
Bendick, Jeanne. **All Around You.** McGraw-Hill, 1951.
Blough, Glenn. **The Tree on the Road to Turntown.** Whittlesey House, 1953.
Blough, Glenn. **Who Lives in This House.** McGraw-Hill, 1957.
Buck, Margaret. **In Yards and Gardens.** Abington, 1952.
Busch, Phyllis. **Lions in the Grass; The Story of the Dandelion, a Green Plant.** World, 1968.
Busch, Phyllis. **Once There Was a Tree; The Story of the Tree, A Changing Home for Plants and Animals.** World, 1968.
Conklin, Gladys. **If I Were a Bird.** Holiday, 1965.
Darby, Gene. **Jerry Finds Ants.** Steck, 1964.
George, Jean. **Hole in the Tree.** Dutton, 1957.
Gibson, Gertrude. **About Insects That Help Plants.** Melmont, 1963.
Hathaway, Polly. **Backyard Flowers; Beginning Knowledge Book.** MacMillan, 1965.
Hawkinson, Lucy and John. **City Birds.** Albert Whitman and Company, 1957.
Hoover, Helen. **Animals at My Doorstep.** Parents, 1966.
LaVine, Sigmund. **Wonders of the Anthill.** Dodd, Mead, 1960.
Radlauer, Edward and Ruth. **Water for Your Community.** Elk Grove, 1968.
Rush, Hanneford. **Backyard Birds; Beginning Knowledge Book.** MacMillan, 1964.
Selsam, Millicent. **How Animals Live Together.** Morrow, 1963.
Shannon, Terry. **Where Animals Live.** Whitman, 1958.
Silverstein, Alvin and Virginia. **Rats and Mice; Friends and Foes of Man.** Lothrop, 1968.

HIGH SCHOOL STUDENTS' AND TEACHERS STS OUTLOOK PROFILES. ARE THERE GENDER DIFFERENCES?

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Recently, the Science/Technology/Society (STS) theme has not only made strides into contemporary science education, but has also been recognized by many as an essential component of present and future science education and general education for all (Bybee, 1987; Yager, 1986; Zoller, 1987). The guiding rationale of the 'STS movement' is that *all* citizens should be capable of understanding and critically analyzing and evaluating issues in the modern science/technology/society interfaces in order to meaningfully participate in the democratic decision-making process (Bybee, 1985; Zoller, 1987). In this respect, the following three categories are of major concern:

1.STS views/positions, that is the *informed* opinions on STS topics and related issues which were defined through the use of the respondents' arguments and reasons. These reasons tend to rely on conceptual knowledge - "misconceptions" included, so that this category emphasizes *cognition* over attitude (Aikenhead, Fleming & Ryan, 1987).

2. STS beliefs/attitudes, that is the three-component concept consisting of belief, feeling and intention to act concerning STS - related issues (Aikenhead, Fleming & Ryan, 1987; Fleming, 1978; Veenker & Torabi, 1983; Zoller, Donn, Wild & Beckett, 1991).

3..STS literacy, that is the combined functional capability of (a) understanding and communicating of the interactions among science, technology and society; (b) technology assessment; and (c) exercising meaningfully the rights and responsibilities of citizenship in technology-dependent democratic societies (Bybee, 1985; Waks, 1986; Zoller, 1987; Zoller, Donn, Wild & Beckett, 1991).

The change in students of the first two, and the attainment of the third by both students and teachers, constitute a focus of continuous effort worldwide (Ben-Chaim & Zoller, 1991; Fleming, 1987; Zoller, Ebenezer, Morley, Paras, Sandberg, West, Walthers & Tan, 1990). Research has shown that appropriate curriculum and teaching does have an impact on students' STS views (Zoller et al., 1990). Thus, these variables can be influenced by *teachers*, they are rightly considered by the advocates of the STS-orientation in current curriculum reforms to be *alterable* and, therefore, can and should be addressed by well-prepared teachers (in STS) within the existing educational settings in order to attain the new goals of science education and education in general. Clearly, the assessment of both students and teachers STS outlook profiles SOPs is a necessary condition both for the successful design, development and implementation of appropriate/responsive STS courses and pre- and/or in-service teacher training programs, as well as for the evaluation of their effectiveness in 'delivering the message' accordingly.

Within the framework of a comprehensive international study of the STS outlook profiles of high school student and teachers we have shown that:

(a) The exposure of high school students to an STS course results in the change of their views/positions (category 1) in the 'desired' direction (Zoller, et al., 1990; Zoller, Donn, Wild & Beckett, 1991).

(b) There are differences between the SOPs of students and teachers in category 1 and 2 but not in 3 (Ben-Chaim & Zoller, 1991; Zoller, Donn, Wild and Becket, 1991).

(c) The students' SOPs are contextually dependent (Zoller et al., 1990).

(d) The expected STS literacy (category 3) of both students and teachers has not been attained (Ben-Chaim & Zoller, 1991; Zoller, Donn, Wild and Becket, 1991).

In view of what is already known concerning gender differences in relation to schooling and education in general and science and technology education in particular (Becker, 1989; Ditchfield & Scott, 1987; Fraser & Gidding, 1987; Kahle, 1998; Keller, 1985; Zoller & Ben-Chaim, 1990), we have focused out special attention on possible gender differences in students' and teachers' SOPs and the implications of such differences for future STS education. This paper reviews the results of our studies in British Columbia, Canada and Israel in this respect. The main objective was to obtain a research-based insight into the gender difference issue in relation to STS education.

METHOD

The research population consisted of 557 grade 11 students (258F, 298M; 302 of whom were 'graduates' of a full year STS course) and 183 teachers (30F, 144M; 40 of whom were STS course teachers) in B.C. Canada, and 546 grade 11 students (264F; 282M; 133, 137, and 276 from the nonscience, science and technological 'tracks' respectively) and 61 teachers (38 science and 23 social study teachers) in Israel (Ben-Chaim & Zoller, 1991; Zoller et al., 1990).

A questionnaire comprised of six statements selected from the VOSTS inventory form CBS mc.4 (Aikenhead, 1987) was used to assess both students' and teachers STS outlook profiles (SOP). The six item/questions (Q1-Q6) were categorized (and therefore selected to begin with) into three categories: (1) views/positions (Q1 & Q2); (2) beliefs/attitudes (Q3 & Q6); and (3) literacy (Q4 & Q5). The six item questionnaire was administered to both students and teachers of the research population who were requested to choose one of the optical responses which followed each item/question. Three terms (one of each category) accompanied only by *selected* optional responses (for the sake of brevity) are given below for insulation (Zoller, Donn, Wild & Beckett, 1991):

1. Scientists and engineers should be the ones to decide on world food production and food distribution (e.g., what crops to plant, where best to plant them, how to transport food efficiently, how to get food to those who need it, etc.) because scientists and engineers are the people who know the facts best.

Your position basically (Please choose one)

Scientists and engineers should decide because:

A. They have the training and facts which give them a better understanding of the issues.

B. The decision should be *made equally*: viewpoints of scientists and engineers, other specialists and the informed public should all be considered in decisions which affect society.

C. The *public* should decide because the decisions affect everyone but scientists and engineers should give advice.

In order to improve the quality of living in Canada (Israel), it would be better to invest money in technological rather than scientific research.

Your position basically (Please choose one)

A. Invest in *technological* research because it will improve production, economic growth, and unemployment. These are far more important than anything that scientific research has to offer.

Invest in *both* because:

B. There is really no difference between science and technology.

D. Invest in *scientific* research - that is medical or environmental research - because these are more important than making better appliances, computers or other products of technological research.

E. Invest in *neither*. The quality of living will not improve with advances in science and technology, but will improve with investments in other sectors of society.

Certain personal characteristics can be important in science (e.g., being open-minded, logical, unbiased, objective, honest). In their research work, scientist display these personal characteristics, more than other Canadians (Israelis) do at work.

Your position basically (Please choose one)

A. Scientists display these personal characteristics *more* because of the nature of their work. Most other Canadians (Israelis) at work don't need to be that way as much.

B. Everyone must have these personal characteristics as much as possible in their work, scientists and non-scientists alike.

The responses to each of the items/statements were categorized and grouped into 'clusters' each of which represents the same view on the issue. A chi-square test for the difference (alpha = 0.05) between the compared groups' profiles was conducted for each of the six items/statements of the questionnaire using the corresponding percentage of usable responses. The results are represented in the form of STS outlook profiles and interpreted in terms of significant or no significant differences between female and male students and teachers.

RESULTS AND DISCUSSION

The STS outlook profiles of STS and non-STS grade 11 female and male students in BC (towards the end of the 1987/88 academic year) are given in figure 1.

A close inspection of figure 1 together with an analysis of the available data reveals that whereas the apparent 'no difference' in positions in Q2 and Q3 persists in both female and male STS and non-STS student populations, there is a significant difference between the SOPs of male but not female STS and non-STS students in Q5. These differences in responses of the two groups *after* belong exposed to an STS course reflect the *different impact of such a course on the female and male students* STS-related views/position. The issue in Q5 is the 'blind idealism' myth propagated by conventional science teaching, that scientists are neutral completely disinterested objective beings. (Q5: *When scientists disagree on an issue, they disagree mostly because one side does not have all the facts. Such scientific opinion has nothing to do with moral values*). It is interesting to note that the STS-male students were more inclined, relative to their non STS-counterparts, to challenge this commonly accepted notion than the STS female students. They believe that personal opinions and moral values do play a role in the interpretation of facts and, consequently, this role affects the position on the issue at point even with scientists. In contrast, non-STS male students are more reluctant, relative to their female counterparts, to challenge the 'accepted in fate' neutrality and objectivity of scientists.

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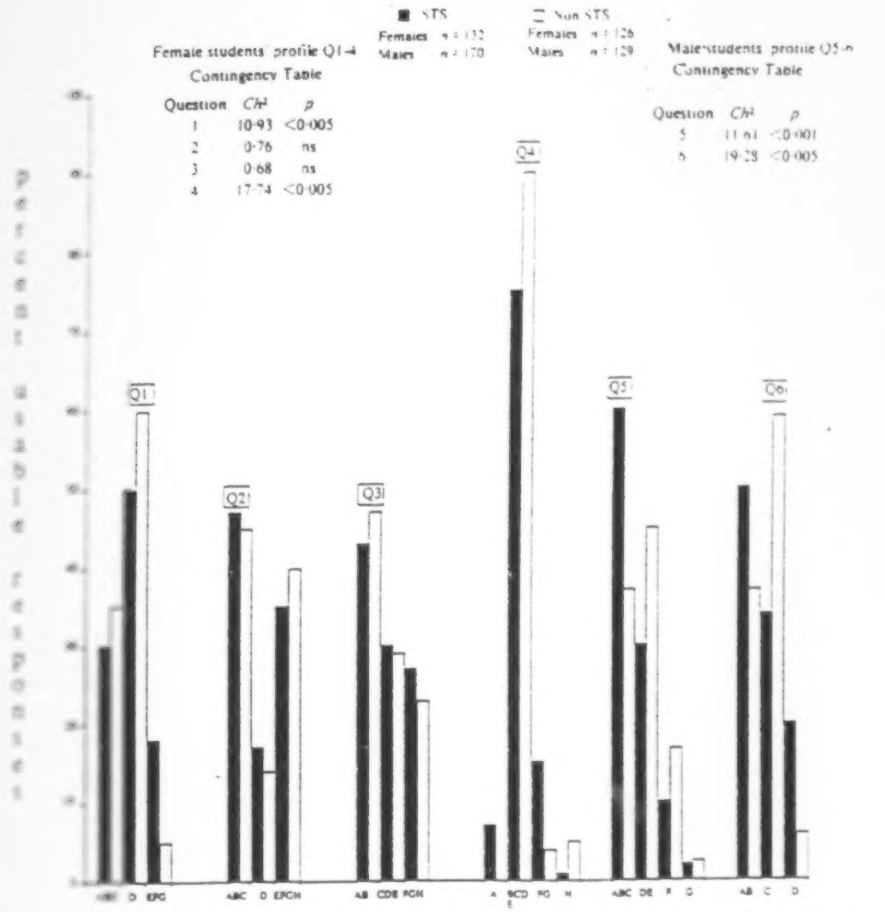
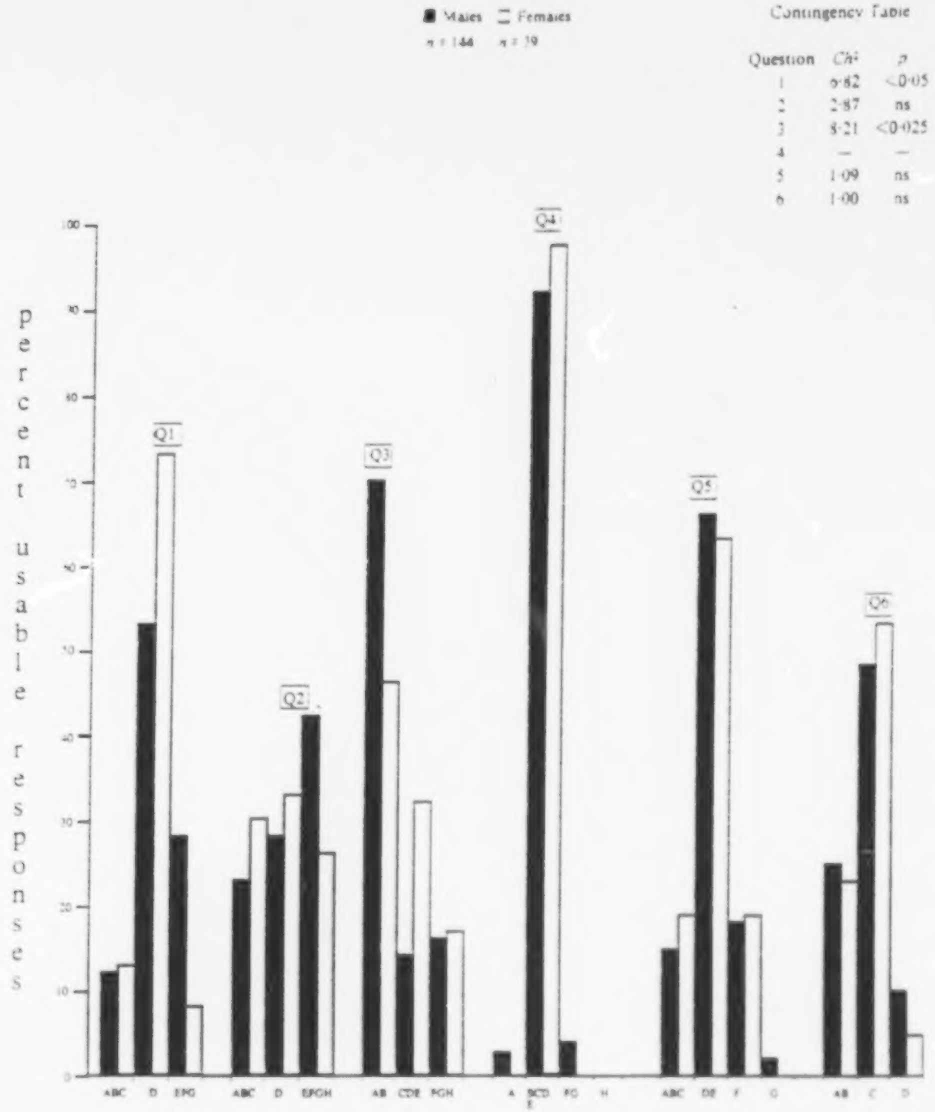


Figure 1 Grade 11 SOPs of STS and non-STS female and male students in B.C., Canada

Figure 1

The SOPs of male versus female teachers in BC Canada (assessed in 1988) are given in Figure 2 below (Zoller, Donn, Wild & Beckett, 1991).

Figure 2 reveals some differences between the SOPs of male and female teachers, mainly in the last two and first two clusters of Q1 and Q3 (categories 1 and 2) respectively. The results of Q1 suggest that the female teachers believed more than male teachers that decisions on technologically-oriented, economic/societal issues should be equally made by the experts (scientists/engineers) and the public, whereas male, more than female teachers, believed that the public (and the government) should decide on such matters. Gender differences are also apparent in the way technology is conceived (Q3): About three quarters of the male teachers, compared with less than half of the female teachers, envisioned technology as the application of science of very similar to it. On the other hand, about one third of the surveyed female teachers, compared with less than 15% of the male teachers,



Contingency Table

Question	Chi^2	p
1	6·82	<0·05
2	2·87	ns
3	8·21	<0·025
4	—	—
5	1·09	ns
6	1·00	ns

Figure 2. SOPs of male and female B.C. teachers.

Figure 2

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TABLE 1:

RESPONSE DISTRIBUTION AND χ^2 ANALYSIS OF THE "ACTIVE" (USABLE):F.SUP '(A)':EF. CHOICES/RESPONSES OF STUDENTS BY GENDER (282 MALES, 264 FEMALES)

Question	Cluster	% of responses		χ^2 value
No.	of choices	M	F	P
	ABC	32.1	24.1	
1	D	57.1	65.9	5.15
	EFG	12.2	10.0	0.076
	ABC	67.1	77.0	
2	D	15.9	11.1	6.07
	EFGH	17.0	11.9	0.048*
	AB	38.1	26.0	
3	CDE	40.6	46.6	7.71
	FGH	21.3	28.0	0.021*
	A	3.7	0.4	
4	BCDE	88.2	92.5	6.36
	FG	5.7	5.3	0.095
	H	2.4	1.8	
	ABC	52.3	50.7	
5	DE	39.2	42.1	0.50
	FG	8.4	7.2	0.780
	AB	38.2	32.7	
6	C	51.4	57.3	1.59
	D	10.6	10.1	0.452

(a) "Passive" responses not used are the last three choices in each question, such as "I don't understand" or "None of these choices fit my basic viewpoint".

define technology in terms of tools, appliances, electronics, computers, and the like, i.e., the 'technical/instrumental' aspect of it. The gender SOPs of 11 grades students int he combined three trends (non-science, science, technology) of Israeli high schools are given below (see Table 1) in terms of the response distribution and X^2 analysis table for all the six items/statements (Q1-Q6) in the questionnaire (Ben-Chaim & Zoller, 1991).

Only minor gender differences could be detected in Q2 and Q3 ($p = 0.0948$ and 0.021 respectively). Those questions are related to categories (1) and (2) respectively. We have already shown that both the high school students' and teachers' SOPS in British Columbia are, to some extent, gender-dependent. Therefore, the gender differences in high school students' SOPS in the same categories found in Israel too, suggest these differences to be something real which deserves further study. It is rather unfortunate that the small number of female teachers (23) in the Israeli teacher research group did not allow a meaningful intra-group statistical analysis (for comparing the SOPs of the two genders) to be conducted. At any rate, the pattern, loci and nature of the gender differences and no differences in the SOPs of both high school students and teachers appear to be quite similar and, most probably, their origin is the same. Our interpretation is that the gender differences, presented and discussed in this paper, should be considered in their 'de facto' rather than 'innate' sense; that is, these gender differences are primarily 'sociological' rather than 'biological'. These differences are related to the traditional 'accepted' and expected role of women versus man in our highly technology-dependent modern society and, therefore, can be educationally coped with within an appropriately designed science education for both students and teachers.

CONCLUSIONS, AND EDUCATIONAL IMPLICATIONS

The assessment of both students ' and teachers' updated STS outlook profiles is a precondition for successful implementation of appropriate STS courses/curricula for the former and effective STS-oriented, pre-service and in-service teacher training programs for the latter. After all, a *change* of students' and teacher's view/positions and beliefs/attitudes, and the acquisition of STS literacy constitute a major goal of STS education. We have found that some gender differences in the SOPs of high school students and teachers *do exist* in categories (1) and (2) for both students and teachers and in category (3) for students. The pattern and nature of these differences suggest them to be sociologically rather than biologically originated. In addition, our findings point out inadequate STS literacy as far as both student and teachers (both genders) are concerned.

In view of the above, a specifically directed effort is called for: that is, appropriate and effective STS courses for students as well as preservice and inservice teacher training programs which take into consideration the gender differences in the SOPs of both students and teachers - should be developed and implemented. The similar findings concerning gender differences in the research populations of two countries so different from one another, not only extend the generalizationability, transferability, and external validity of our findings and conclusions, but also provide a deeper insight into the educational and curricular issues involved with STS education and teaching.

The present study provides a research-based rationale for future gender-related policies and practices in science education. its contribution to the future design, development, implementation, teaching and evaluation of STS-oriented science courses is thus clear.

REFERENCES

Aikenhead, G.S. (1987). a. Views on Science-Technology-Society. Form CDN.mc 4. Department of Curriculum Studies, University of Saskatchewan, Canada. b. An analysis of four methods which assess students' beliefs about science. Paper presented at the 60th Annual Meeting of the National Association for Research in Science Teaching, Washington, D.C.

Aikenhead, G.S., Fleming, R.W., and Ryan, A.G. (1987). High-school graduates' beliefs about science-technology-society. Methods and issues in monitoring students views. *Science Education*, 71, 145-161.

Becker, J.B. (1989). Gender and science achievements: A reanalysis of studies from meta-analyses. *Journal of Research in Science Teaching*, 26(2), 141-169.

Ben-Chaim, D., and Zoller, U. (1991). The STS outlook profiles of Israeli high school students and their teachers. *International Journal of Science Education*, 13, 447-458.

Bybee, R.W. (1985). The sisyphean question in science education: what should scientifically and technologically literate persons know, value and do as a citizen? In R.W. Bybee (Ed.), *Science-Technology-Society (1985 Yearbook*. (Washington, D.C.: National Science Teachers Association).

Bybee, R.W. (1987). Science education and the Science-Technology-Society (S/T/S) theme. *Science Education*, 71, 667-683.

Ditchfield, C. & Scott, L. (1987). *Better Science: For Both Girls and Boys*, London: Heineman.

Fleming, R.W. (1987). High school graduate beliefs about Science-Technology-Society. The interaction among science, technology and society. *Science Education*, 72, 163-186.

Fraser, B.J. & Gidding, G. (1987). *Gender Issues in Science Education*, Perth: Crtin University Press.

Kahle, J.B. (1988). *Women in Science*. A report from the field. London: Falmer Press.

Keller, E.F. (1985). *Reflections on Gender and Science*. New Haven: Yale University Press.

Veenker, C.H. and Torabi, M.R. (1983). Multivariate analysis of dimensionality in health attitude structure. *Health Education*, 14, 16-20.

Waks, L.J. (1986). Reflections on Technological Literacy. *Bulletin of Science Technology and Society*, 6, 331-336.

Yager, R.E. (1985). An alternative view. *Journal of College Science Teaching*, 14, 223-224.

Yager, R.E. (1986). Restructuring science teacher education programs as they move towards an STS focus. In R.K. James (Ed.), *Science Technology and Society Resources for Science Educators*, 1985 AETS Yearbook, Columbus, Ohio: Association for the Education of Teachers in Science and SMEAC Information reference Center, pp. 46-55.

Zoller, U. (1987). Problem solving and decision-making in science-technology-environmental society (STES) education. In K. Riquarts, (Ed.), *Science and Technology and the Quality of Life*. Proceedings of the 4th International Symposium on World Trends in Science and Technology Education. (Kiel: IPN Materiale), Vol. 2, pp. 562-569.

Zoller, U. & Ben-Chaim, D. (1990). Gender differences in examination type preferences, test anxiety, and academic achievements in college science education - a case study. *Science Education*, 74(6), 597-608.

Zoller, U., Ebenezer, J., Morley, K., Paras, S., Sandberg, V., West, C., Walthers, T., and Tan, S.H. (1990), Goals' attainment in Science-Technology-Society (S/T/S) education and reality. The case of British Columbia. *Science Education*, 74 (19-36.

Zoller, U., Donn, S., Wild, R., and Beckett, P. (1991). Students versus their teachers' beliefs and positions on Science-Technology-Society (STS) oriented issues. *International Journal of Science Education*, 13(1), 25-36.

HOW A CITY WORKS: A Professional Development Institute for Teachers

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The MIT Strategy

For the last six years, the MIT Council on Primary and Secondary Education (CPSE), has led MIT's efforts to contribute to the improvement of science and technology education in U.S. schools. It has focused on the professional development of presently active teachers and on the training of new teachers. This paper describes on major program created by the Council.

We felt that city children might be attracted to the study of technology and science if they saw it as a way to understand their social and material surroundings and eventually as a way to control them. We therefore tried to prepare some of their teachers to examine How a City Works: to define the resources locally available to them for that purpose, and to encourage them to design open-ended interdisciplinary hands-on projects suitable for their students. We discovered that it was also essential for us to develop the teachers' leadership abilities and their teamwork skills. Finally, we concluded that the teaching and learning styles required by this approach would not fit comfortably in the current institutional and schedule mold of most American public schools, and we were therefore led to include the need for systemic change (and some ways to achieve it) in our message to the teachers with whom we worked.

Our strategy in 1993-94 was to invite the participation of teams from particular schools and school districts. A team generally consisted of five teachers drawn from one school - occasionally a High School or a Vocational School and one of its feeders - teachers of math, science, vocational skills, social studies or English. In addition, the team included one school administrator and one lay person drawn from the Community served by the school - a parent, an academic or an engineer, a businessperson, and occasionally a School Board member.

Ten teams attended a three week residential workshop at MIT on July 12-30, 1993 and then participated in a follow-up program which included particularly the organization of an activity on their home turf in Spring or Summer 1994 to share their new wisdom with colleagues and lay plans for local school reform.

The Summer Program

During the first week of the Summer Program, the teams performed a series of simple tasks designed to get them to work together as a unit. For example, they built a bridge out of wrapping paper and tongue depressors, which spans 18 inches and supports a 12 ounce robot vehicle 6 inches wide. The materials were assigned a price and a prize was awarded to the team who built the cheapest bridge able to carry the load.

They also brainstormed to create a "wish-list" of changes which would improve the operation of their school - they returned to that list in the third week of the workshop.

In the latter part of the first week, they participated in field trips to see for themselves how a central telephone switchboard works, how the Massachusetts Bay Transit Authority schedules and maintains its trains and buses, or how a water treatment plant works. They also heard several background lectures given by MIT faculty or engineers practicing in the urban technologies.

They became familiar with the notion of "webbing" or creating visual models of how the physical and institutional components of a system interact. Actual examples of such "webs" are shown on Figs. 1 and 2. These webs were created by groups or participants individually calling out important components and suggesting where they fit in the system.

At the end of Week One, the participants were ready to undertake technical assignments. These focused on the supply and treatment of water and on mass transit in 1992, and on the construction of public facilities and the workings of an urban telephone system in 1993. They will concentrate on electric light and power networks and on public health and health delivery services in 1994. In 1993, the teams undertook the following projects:

Construction Projects

1. Concrete technology
2. Zoo design
3. Providing handicapped access to an old MIT building
4. Cellular telephones
5. Fibre optic transmission

Telephone Projects

1. The AT&T "500" telephone
2. Telephone switching
3. Telephone security
4. Cellular telephones
5. Fibre optic transmission

In each case, the participants researched the technical and societal background of their project, acquired some understanding of the underlying science and technology, built a working model (or a mockup in the case of the zoo design project) and wrote a report of their activity. Early in the third week of the workshop, each team displayed their project in the style of a "science fair." In carrying out their work, each team had the support of an advising group consisting of an MIT faculty or staff (or a local senior engineer) and an MIT undergraduate. The senior advisor was not a specialist in the field of the project, so that he/she was also learning as the project went on.

It turned out, in fact, that the advisor's main task was not to guide team members in the intricacies of the technologies involved, but rather to facilitate teamwork, to moderate arguments among team members and to give everyone a chance to contribute to the common work.

An example of a project is illustrated on Figures 3, 4 and 5 which display the team strategy and the construction of background for their project. The technical part of the exercise included floor plans of several alternative temporary buildings and a scaled-down plywood model. The technical design teams consist of teachers from different systems - in this case from Boston, Yarmouth, Maine and two schools in Dallas. The practice was to keep geographical teams together the first week to discuss their school system; to shuffle the teams for the technical projects both to encourage exchanges of views and to give teachers a chance to pick their project; and then to reassemble the geographical teams in the third week so that they could compare notes and draw conclusions appropriate to their circumstances.

Indeed, the third week was devoted to group discussions of the dynamics of systemic change in schools, to the stresses and insecurities which result from doing things in a new way, particularly when the teacher sees her/his role shifting from that of the ultimate authority to that of a fellow investigator. Some time was also spent in starting the planning of the local follow-up activities which each team was committed to undertake.

We emphasize that our goal has not been to produce curriculum materials or to encourage teachers to produce such materials. It was rather to introduce them (or re-introduce them) to the examination of their school as a system (and a component of a larger system), and of urban technologies as systems, in the hope that they would see useful analogies as a result, and that this would color their subsequent planning. In fact, the participation of administrators and community representatives was essential to that process.

The Follow-up Winter 1993-94

The follow-up activities during the school year were designed in the light of these expectations. They include a hot line and the opportunity to network by e-mail (America Online) and by telephone conferences; the option of school systems to invite their advisors (particularly the MIT undergraduates) for visits in January 1994; and the use of materials developed in the Summer, where teachers find it comfortable. We visited classrooms where the teacher took advantage of the "webbing" technique, and classrooms where the students build models of cities which emphasized their technical underpinnings. But the main business of the teams' follow-up was the planning of their activities in 1994.

This included some system-wide discussions to define the target participants - usually teachers at other schools in the system - and the format and topic of the planned activities. One school system is using their local resources and some support from MIT to collect materials and ideas for a set of curriculum units on health care in a broad context (e.g., what is "illness" in various cultures; how are epidemics handled - and on what basis; and how does the public health system work in their community and provide jobs in health related industries).

Another has scheduled a three-day "Team Works" activity which stresses team-building activities with a technical focus: building a bridge, playing (and discussing) the Sim City Computer Simulator Game, and designing a collaborative learning experience.

Yet another is organizing a three-day workshop entitled "Opening the Door - Educators Exploring a Factory Environment," open to any team of two or more teachers who work together. It aims to improve collegiality within the school community and between school and business communities, to develop a better understanding of systems, to see how a factory works and how to design demonstrators which can be used in the classroom.

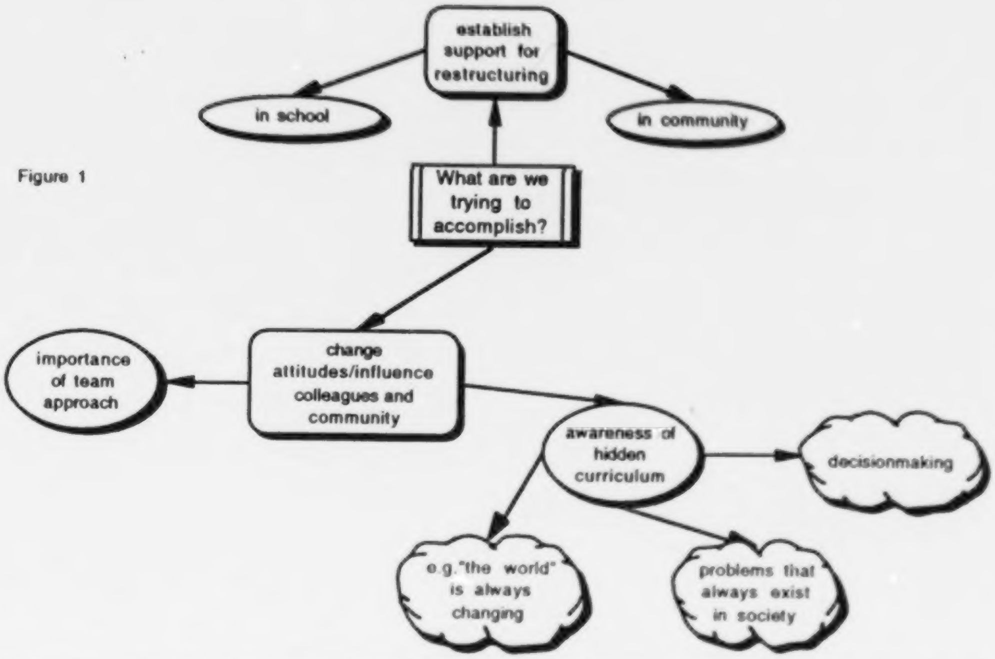
Altogether, six participating teams have shown us plans for their follow-up activities for Summer 1994 and two other have discussed theirs informally. The original hopes for follow-up and diffusion appear to be realizing themselves and will be amplified with the class of 1994. The general plan of action is outlined on Figure 6.

Evaluation

How does one evaluate this program? Its goal is to change the attitudes of the participating teachers in the expectation that in due time that change will have consequences on the learning of their students and on the operating style of their systems. It is much too early to measure such consequences, which will emerge slowly over a number of years. But it is possible to get a sense of the teachers' reactions, from a combination of questionnaires and of free writing exercises done over the first year of their participation, and from observation of their actions during the year.

We found that most of the teachers liked their experience on the whole. They realized that they could understand technology in a societal context, and most of them thought that what they discovered was fascinating and appropriate in some form for their students. They also concluded that learning to work in teams and undertaking projects without knowing the outcome in advance called for difficult personal adjustments - they were forms of risk taking both exhilarating and slightly frightening. Predictably, most teachers claimed that the agenda was too charged and did not leave enough time for personal thought; and that the way their projects were organized and displayed overemphasized competition between teams - a somewhat unintended reflection of the MIT style on the workshop activities. But the most directly observable effect of this program lies in the degree of enthusiasm and skill with which the participants organize their own workshops and work at changing their own workshops and work at changing their immediate surroundings and their personal learning and teaching styles. So far, with much encouragement, they are beginning to change.

Figure 1


establish support for restructuring
in school
in community
What are we trying to accomplish?
change attitudes/influence colleagues and community
importance of team approach
awareness of hidden curriculum
decisionmaking
e.g."the world" is always changing
problems that always exist in society

IDEAS FOR ADVERTISING THE WORKSHOP (WHAT TO CALL IT?)

Figure 2

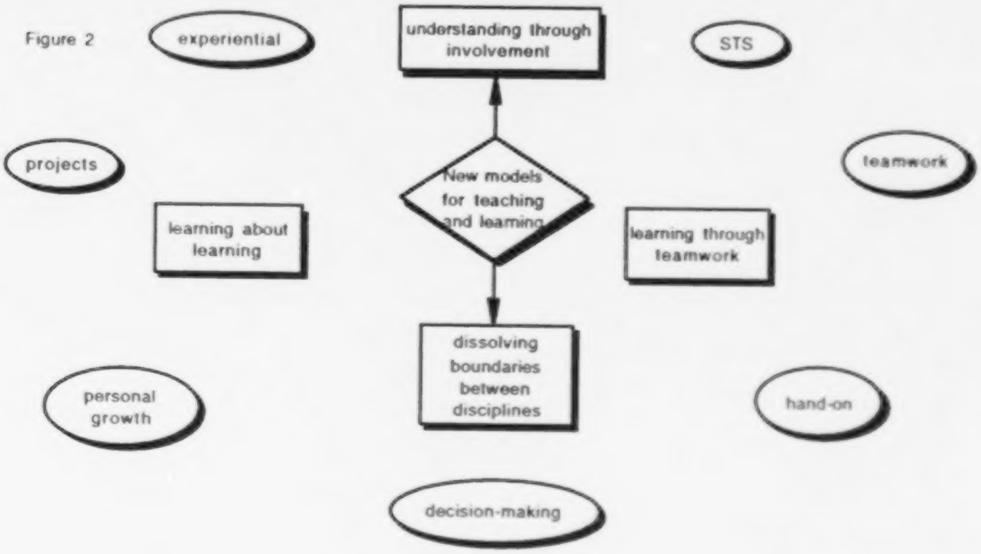

experiential
understanding through involvement
STS
projects
New models for teaching and learning
teamwork
learning about learning
learning through teamwork
dissolving boundaries between disciplines
personal growth
hand-on
decision-making

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Figure 3

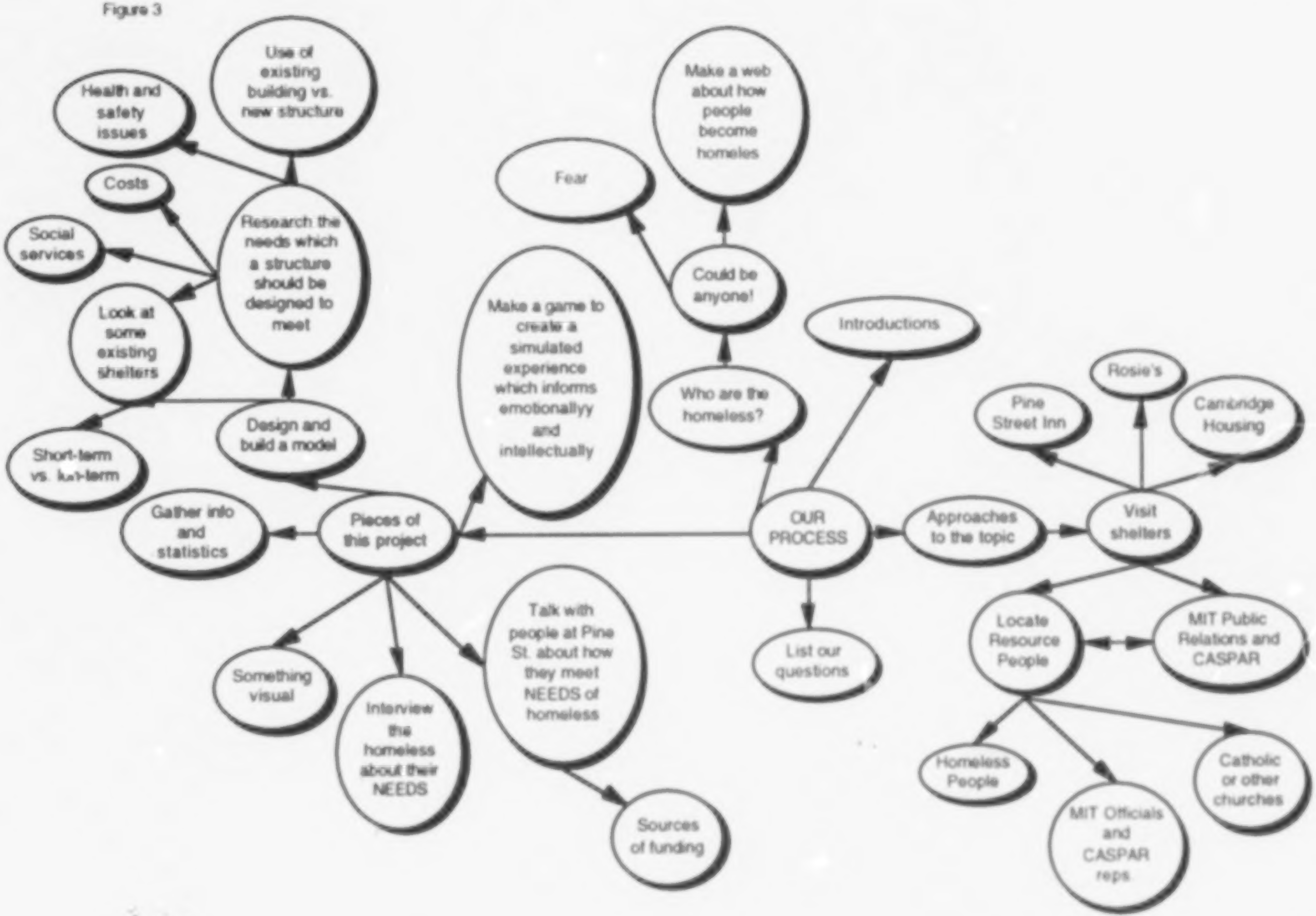
OUR PROCESS
Introductions
Who are the homeless?
Could be anyone!
Fear
Make a web about how people become homeles
List our questions
Approaches to the topic
Visit shelters
Pine Street Inn
Rosie's
Cambridge Housing
Locate Resource People
MIT Public Relations and CASPAR
Homeless People
MIT Officials and CASPAR reps
Catholic or other churches
Pieces of this project
Make a game to create a simulated experience which informs emotionallyy and intellectually
Gather info and statistics
Design and build a model
Research the needs which a structure should be designed to meet
Use of existing building vs. new structure
Health and safety issues
Costs
Social services
Look at some existing shelters
Short-term vs. long-term
Something visual
Interview the homeless about their NEEDS
Talk with people at Pine St. about how they meet NEEDS of homeless
Sources of funding

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Figure 4
How do people become homeless?

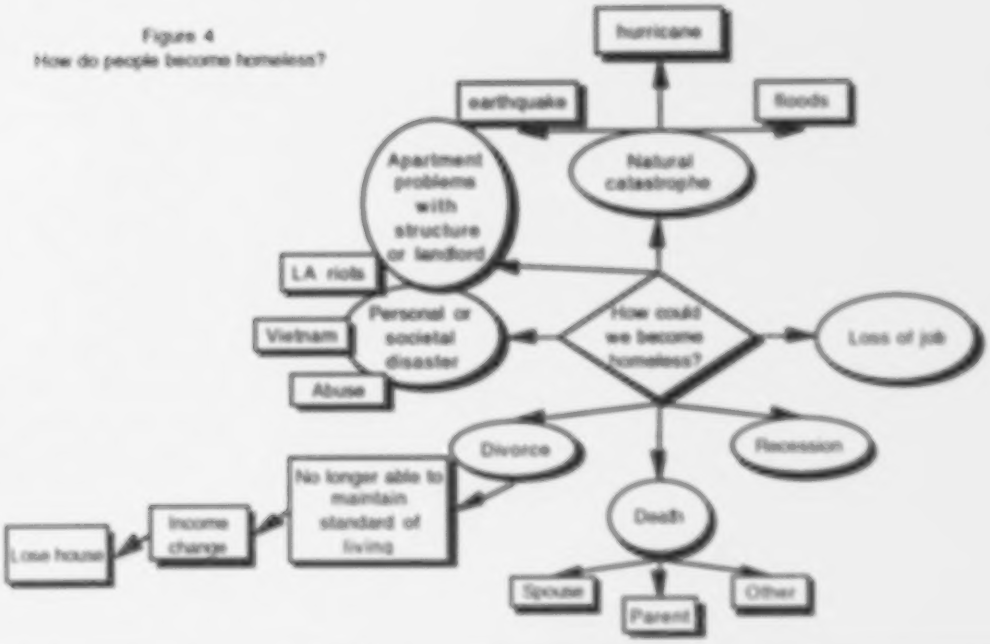
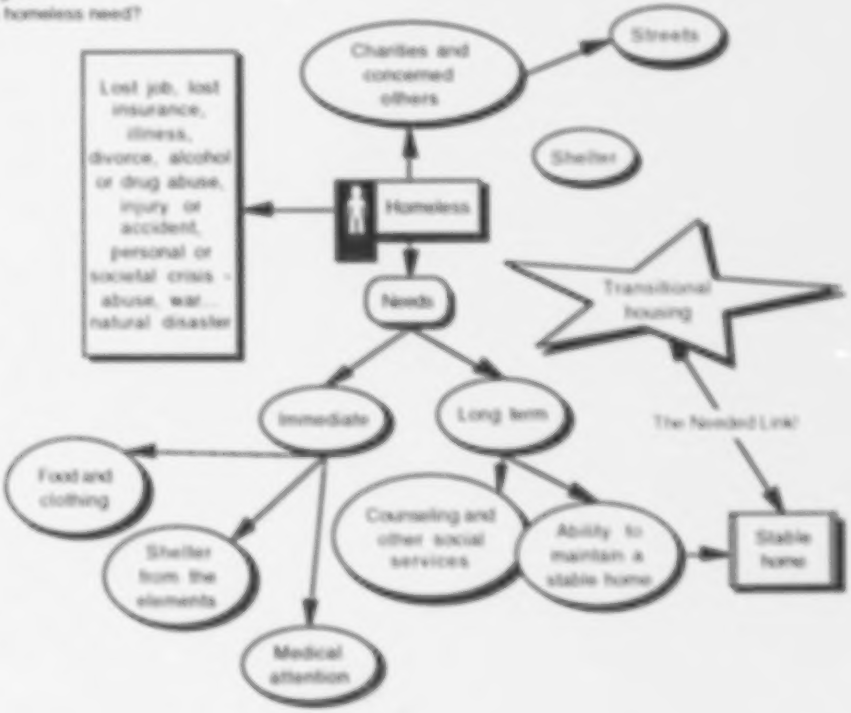

hurricane
earthquake
floods
Apartment problems with structure or landlord
Natural catastrophe
LA riots
Personal or societal disaster
Vietnam
Abuse
How could we become homeless?
Loss of job
Divorce
Recession
No longer able to maintain standard of living
Income change
Lose house
Death
Spouse
Parent
Other

Figure 5
What do the homeless need?


Charities and concerned others
Streets
Shelter
Lost job, lost insurance, illness, divorce, alcohol or drug abuse, injury or accident, personal or societal crisis - abuse, war... natural disaster
Homeless
Needs
Transitional housing
The Needed Link!
Immediate
Long term
Food and clothing
Shelter from the elements
Medical attention
Counseling and other social services
Ability to maintain a stable home
Stable home

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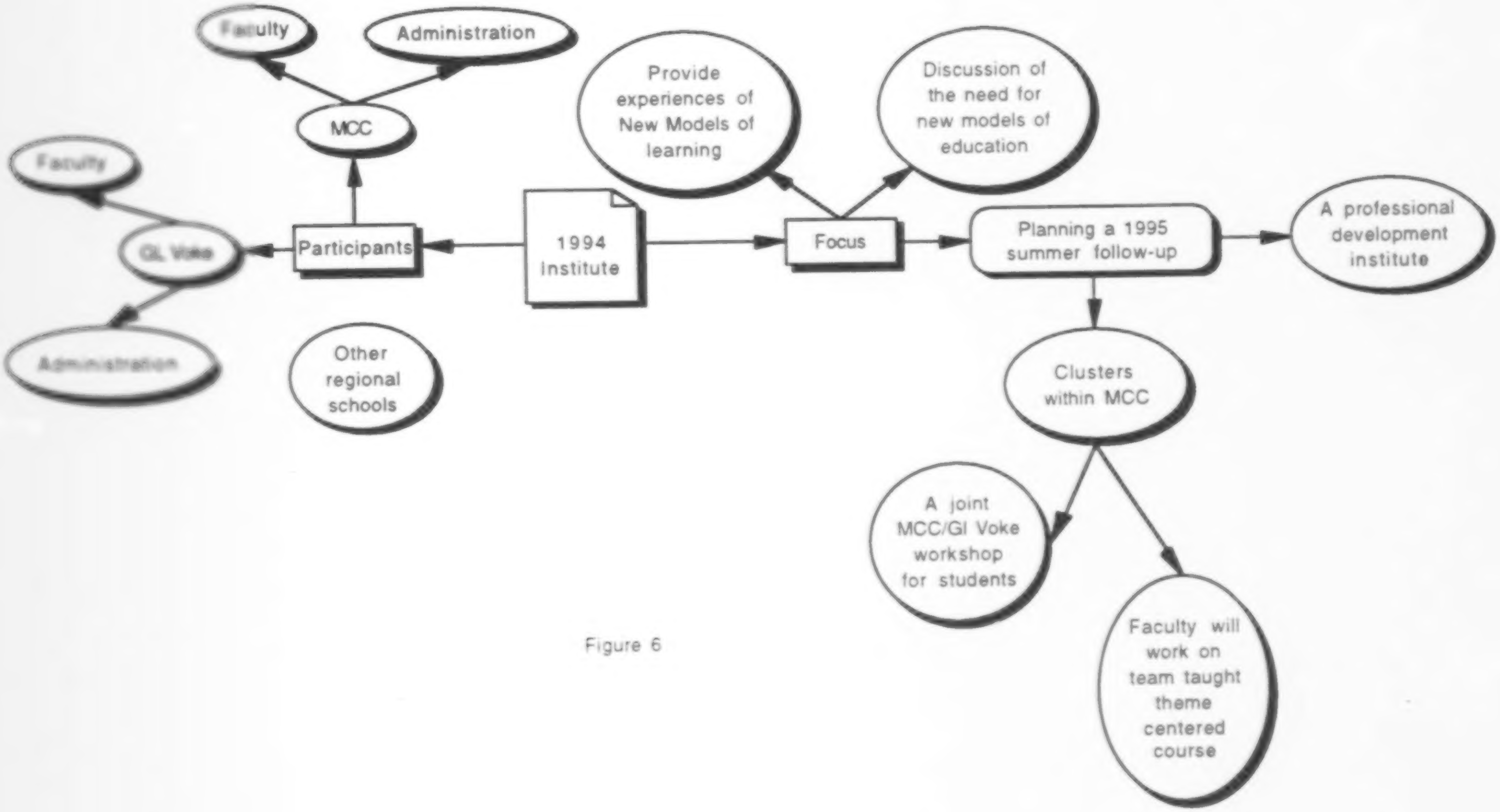
Faculty
Administration
MCC
Faculty
GI Voke
Participants
Administration
Other regional schools
1994 institute
Provide experiences of New Models of learning
Discussion of the need for new models of education
Focus
Planning a 1995 summer follow-up
A professional development institute
Clusters within MCC
A joint MCC/GI Voke workshop for students
Faculty will work on team taught theme centered course

Figure 6

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TECHNOLOGIES, BOUNDARIES, AND REALITIES:

DANCING ON THE BORDERS OF HUMAN AND MACHINE

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TECHNOLOGIES, BOUNDARIES, AND REALITIES: DANCING ON THE BORDERS OF HUMAN AND MACHINE I:

A DECONSTRUCTIVE DEMI-DANCE

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> *Cyborg imagery can suggest a way out of the maze of dualisms in which we have explained our bodies and our tools to ourselves. . . .*
> *It means both building and destroying machines, identities, categories, relation-ships, space stories.*
> *(Haraway, 1985)*

In 1995, we mark the passage of a decade since Donna Haraway first published her "Cyborg Manifesto," and with this publication opened a new and provocative discussion of life on the borders of human and machine. In the flow of cyborgian literature since that time, it is often forgotten that Haraway's paper was originally a contribution to feminist theorizing and politics; her full title was "Manifesto for Cyborgs: Science, technology, and socialist feminism in the 1980s" and she had presented parts of this paper at perhaps a half-dozen feminist conferences prior to publication. It is important to recall that the cyborg evolved in Haraway's work as a figure to use in theorizing about and with an audience which was, and is, generally hostile to technologies. Cyborg imagery is used by Haraway to make two crucial arguments; in her words these are,

> first, the production of universal, totalizing theory is a major mistake that misses most of reality, probably always, but certainly now; and second, taking responsibility for the social relations of technology means refusing an anti-science metaphysics, a demonology of technology, and so means embracing the skillful task of reconstructing the boundaries of daily life, in partial connection with others, in communication with all our parts. (p.181, 1991)

Examining the current state of affairs in our postmodern world, especially as it concerns issues of racial difference, Cornel West has said "In these downbeat times, we need as much hope and courage as we do vision and analysis." (1994, p. 159). As a means of examining, transgressing, and dissolving racial, gender, and other divisions and boundaries in our high-tech world, the cyborg is not only a tool of analysis, but a figure of hope and courage. Again citing Haraway (p.151, 1991), "The cyborg is resolutely committed to partiality, irony, intimacy, and perversity. It is oppositional, utopian, and completely without innocence." Through exercise of these commitments, Haraway's cyborg can help us cross boundaries, not only in the production of theory, but in the conduct, understanding, and redirection of everyday life on both the individual and political scales.

In some senses, the cyborg metaphor, and the discussion surrounding it, provides direction for new lines of inquiry and "permission" to engage in scholarly and "scientific" work on boundaries and boundary crossings. But, Haraway provides no hint as to which particular boundaries we might address most fruitfully. The number of boundaries to which we might turn our attention is seemingly infinite. Both the production of universal totalizing theories and the reification of social relations of technology are pervasive, working together in myriad ways and strengthening each other and the borders they define.

In this symposium, we make initial forays into three very different boundary spaces. "Dancing on the borders of human and machine" in our title refers to the radical act of playfully, but seriously, engaging in discourse hopping, flitting from one salient idea to another not because they are logically connected but because they shore each other up to create complex boundaries in day-to-day life. Following Haraway, we "embrac[e] the skillful reconstructing of the boundaries of daily life" (p. 181); we do so by attending to ways that master discourses operate along these boundaries. Several dozen scholars are working with the image of the cyborg and the multiple boundary crossings it entails to build new conceptual spaces for examining and reworking the relations of persons, schools, professions, ideas, and technologies. Working among them, we recognize both the threat that ideas of social constructedness pose to the maintenance of and belief in something unequivocally called "reality" and the importance of technologies to that social construction. At the same time, however, we note that even as the world is socially constructed, at each location in this construction a person may live a real life--the only reality she or he may know. Recognizing this, we think globally, but dance locally.

In our work, we honor these realities, even as we explore the ironic cyborgian boundary crossings of human and machine which are entailed in their construction. Each of the papers in this symposium provides discussion focused on a specific boundary between/coming together of persons and technologies. Linda Condron discusses her research concerning women computer scientists who reside on the human/machine boundary as well as the multiple discursive and political boundaries separating "women's realm" from "men's realm". She examines the transparency/ opacity of technology for these women in terms of envisioning, creating, using, interpreting, and understanding not only their technologies but themselves.

For women in engineering, technology is a marker of some prestige and success; Condron shows ways in which this marker can both facilitate and inhibit boundary crossings.. For others, however, technology can be a marker of difference. Jan Johnson examines the ways in which persons with disability confront the possibility of changing the realities of their disabilities through technology. At the same time, these technologies are paradoxically creating other realities that may be defined by a different set of limitations. Johnson describes for us instances showing boundary-riding related to independence/ dependence, liberation/ repression, and individualism/ community.

Johnson's discussion suggests ways in which technology development and "ableism" are deeply entailed in each other. Her work provokes thought about the vocabulary of "persons with disability" as opposed to "differently abled" persons, and suggests that the latter term might serve better to leave us all open to lessons concerning all technology; the differently abled have been positioned in ways which may allow them to be uniquely able to inform us if we are open to that information. The importance of vocabulary to our perceptions of technology brings me to Shaffer's paper. Allen Shaffer uses this theme in examining phenomenology and virtual reality. In many cases, he argues the desired and achieved transparency of technology seems like the "natural attitude" associated by phenomenologists with a deliberate suspension of disbelief in the facticity of technological affairs. He considers how this suspension of disbelief is carried out and how it is deliberate. Citing instances which point to significant dissonance between the range of what is there to be believed about technology and what we believe in everyday life, Shaffer asks how these issues are reflected in terms and concepts such as "virtual reality"? And, importantly, who benefits . . . and how?

For further discussion in relation to the three specific topics, the reader is referred to the papers which follow. In the remaining paragraphs of this paper I examine the ways in which these three papers can serve as models of three different kinds of technological boundary constructions encountered and in need of "skillful reconstruction." Briefly, these are: (1) braided boundaries in which multiple dividing lines are woven together, (2) boundaries reified with technologies of salvation, and (3) shifting boundaries created by discourses of technologies of appropriation. Analyses of these boundary constructions point to the importance of excavation before attempting reconstruction.

Braided boundaries and the gendered culture of technology. Numerous discourses relate gender and technology. As Condron (1994) points out, these discourses produce stories of access granted or denied, of questioned ability, of repression and oppression, and of other experiences; these are woven together by women to serve as both direction and explanation for her relation to and separateness from technology. As they are braided together, each of these discourses both interrupts and multiplies the strength of the others. To dance on the braided boundary is to establish a fleeting footing on one discourse until the music of day-to-day activity carries the dancer to step on a different boundary with the other foot. Examining the ways in which women who have chosen careers in computing negotiate their lives, Condron (1995) explicates how they negotiate the available discourses of technology, crossing the boundaries between them. Moreover, she finds, these women are able to maintain a separateness of themselves from the corporate machine. Through their multiplicity and interelatedness, the same discourses which bound women's relation to technology, seem to afford these women an escape from their potentially totalizing effects.

Recent work on the gender-technology relation (e.g., Fitzsimons, 1994; Grint and Gill, 1995) reverses the direction in which several of these discourses operate, replacing questions of how gender operates to construct conceptions of technology with questions concerning how technology constructs gender. Condron's paper contributes to this move at the level of individual lives.

Technologies of salvation and the reification of boundaries. By technologies of salvation I mean those technologies which are designed with the single purpose of providing remedy to "non-normality." Thus, these technologies are rooted deeply within the normalizing and normatizing discourses of society and, therefore, often escape critique. As Johnson illustrates in her paper, even as these technologies work toward the normalization of life for "non-normal" persons, they construct new boundaries of normality, thus reifying and reproducing the privileging of the "normal." The nearly universal acceptance of these technologies renders their critique difficult, if not unthinkable. Absence of critique itself continues the reification. In addition to Johnson's example of assistive technologies, neonatology and various technologies of body-part replacement participate in this category. The ethical dilemmas surrounding these technologies would be well-served by further excavation of the boundaries which motivate and/or arise from development in these areas.

Shifting boundaries and technologies of appropriation. By technologies of appropriation, I mean those technologies which are designed to replicate and/or expand "real world" phenomena. Various modeling technologies and much scientific apparatus reproduce certain aspects of the "real world" and are included in this category. Like (and including) "technologies of the individual" (see Damarin, 1993; Ihde, 1990), these technologies work best when they appear invisible, transparent, or in seamless relation to the phenomena they extend. Unlike technologies of salvation which serve to reify the normal, these technologies displace the normal in order to control it. Unbridled use of these technologies serves to redefine the discourse of normality, that is, to shift the boundary conditions which inscribe "the normal." Shaffer's paper provides an example of resistance to this redefinition by demanding that phenomenology, its methods and resources, be left intact. Thus, he is engaged in "skillful reconstruction" of an extant boundary even as VR technologists and their adherents strive to shift the boundary of "reality" to another location.

Concluding thoughts. Although it is useful to categorize technologies in order to examine (and sometimes to resist) their specific effects, categorical systems are themselves technologies of boundary building. While they can facilitate certain analyses, they preclude others. A slight change in focus of the categories described above would reveal assistive technologies as appropriative, virtual reality as inscribed in braided discourses, and the discourses of gender and technology as narratives of salvation (of women, of capitalism, of U.S. hegemony in the marketplace). Finally, the Haraway quote which begins this paper claims that cyborg imagery can help us out of dualisms which are fundamental to how we understand ourselves and our technologies. Building, destruction, and more building of categories, boundaries, and machines are among the cyborgian techniques appropriate to this endeavor and adopted in the papers of this symposium. The cyborg's work is never done.

References

Condron, Linda. (1994). *Women engineers: How they understand their experience: A Dissertation proposal.* Unpublished manuscript.

Condron, Linda. (March, 1995). Technologies, boundaries, and realities: Dancing on the borders of human and machine II: Women computer scientists. Paper presented at the annual meeting of the National Association for Science, Technology, and Society. Washington, DC.

Damarin, Suzanne K. (1993). Technologies of the individual: Women and subjectivity in the age of information. In Joan Rothschild (Guest Ed.) & Frederick Ferre (General Ed.), *Research in philosophy & technology, 13: Technology and feminism* (pp. 183-198). Greenwich, CN: JAI Press, Inc.

Fitzsimons, Annette. (1994). Women, power and technology. In Kathleen Lennon & Margaret Whitford (Eds.), *Knowing the difference: Feminist perspectives in epistemology* (pp. 122-131). New York: Routledge.

Grint, Keith & Gill, Rosalind. (1995). *The Gender-technology relation: Contemporary theory and research.* London: Taylor and Francis.

Haraway, Donna J. (1991). A cyborg manifesto: Science, technology, and socialist-feminism in the late twentieth century. In *Simians, cyborgs, and women* (pp. 149-181). New York: Routledge.

Ihde, Don. (1990). *Technology and the lifeworld.* Bloomington, IN: Indiana University Press.

Johnson, Jan. (March, 1995). Technologies, boundaries, and realities: Dancing on the borders of human and machine III: The Paradox of technology for persons with disabilities. Paper presented at the annual meeting of the National Association for Science, Technology, and Society. Washington, DC.

Shaffer, C. Allen. (March, 1995). Technologies, boundaries, and realities: Dancing on the borders of human and machine IV: Yellow roses: The Case against the name 'virtual reality'. Paper presented at the annual meeting of the National Association for Science, Technology, and Society. Washington, DC.

West, Cornel. (1993). *Race matters*. New York: Vintage Books.

TECHNOLOGIES, BOUNDARIES, AND REALITIES: DANCING ON THE BORDERS OF HUMAN AND MACHINE II:

WOMEN COMPUTER SCIENTISTS

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"The cyborg is our ontology; it gives us our politics."
(Donna Haraway, 1991, p. 150)

Working to keep Donna Haraway's *Cyborg Manifesto* in the foreground, in this paper I discuss some of the interview data from my research with women computer science professionals, who dance on the borders of men's work and women's work, as well as the borders of human and machine.

Cyborgian Theme

In recent years a discourse has built up around the ideas of Donna Haraway. She has challenged many feminists, philosophers, and scholars interested in the interplay between science and technology, and people and "nature," in her playful, ironic, and insightful writings. In her famous *Cyborg Manifesto* (1991) she notes that the cyborgs (machine-organism hybrids) of science fiction are indeed a social reality. She proceeds to "signal three crucial boundary breakdowns" (p. 151) associated with late twentieth century United States science/fiction/politics, and argues for "*pleasure* in the confusion of boundaries and for *responsibility* in their construction" (p. 150). About the first of these boundaries, (white) (hu)man-animal, she writes:

> By the late twentieth century in United States scientific culture, the boundary between human and animal is thoroughly breached. The last beachheads of uniqueness have been polluted if not turned into amusement parks -- language, tool use, social behaviour, mental events, nothing really convincingly settles the separation of human

> and animal. And many people no longer feel the need for such a separation; indeed, many branches of feminist culture affirm the pleasure of connection of human and other living creatures. Movements for animal rights are not irrational denials of human uniqueness; they are a clear recognition of connection across the discredited breach of nature and culture. (p. 151-2)

The second boundary breakdown Haraway comments upon is that of organism-machine:

> Late twentieth-century machines have made thoroughly ambiguous the difference between natural and artificial, mind and body, self-developing and externally designed, and many other distinctions that used to apply to organisms and machines. Our machines are disturbingly lively, and we ourselves frighteningly inert. (p. 152)

And further, she writes:

> Who cyborgs will be is a radical question; the answers are a matter of survival. (p. 152-3)

Finally, Haraway comments upon the third boundary breakdown she has identified, that of the physical-nonphysical:

> The third distinction is a subset of the second: the boundary between physical and non-physical is very imprecise to us. . . Our best machines are made of sunshine; they are all light and clean because they are nothing but signals, electromagnetic waves, a section of the spectrum, and these machines are eminently portable, mobile -- a matter of immense human pain in Detroit and Singapore. People are nowhere near so fluid, being both material and opaque. Cyborgs are ether, quintessence. . . The ubiquity and invisibility of cyborgs is precisely why these sunshine-belt machines are so deadly. They are as hard to see politically as materially. They are about consciousness -- or its simulation. (p. 153)

It is mainly the organism-machine boundary breakdown, with its physical-nonphysical subset, with which I am concerned in this paper. To the extent that we merge with our technologies, they become transparent for us, and we can, in failing to see them, fail to think critically about them. Borrowing from Don Ihde, Suzanne Damarin (1993) uses eyeglasses as an example of what she calls "technologies of the individual," pointing out that the more invisible they become to the user, i.e., the less conscious the user is of them, the more effectively they are used. Just as I would not suggest that we forego the use of eyeglasses, neither do I condemn out of hand the technological endeavors of the women computer scientists who participate in my research. Haraway offers us the cyborg as both "a tool of analysis" and "a figure of hope," as Damarin (1995) points out.

The mere presence of women in the prestigious and male-dominated technological arena represents a breach of boundary. The field of computer science is an appropriate site at which to observe cyborgian ontology and the blurring of formerly distinct boundaries. Computer technology has been undergoing enormous development in the past 30 years. In some projects, for instance, computer scientists, in collaboration with scientists from other disciplines, attempt to predict and imitate with machines the kind of thinking people do. Ironically, however, at the same time that machines so poorly approximate the ways of people, people are, more and more, being expected to interact with one another in machine-like fashion. In interviews with women computer science professionals, I seek information to help me understand how they navigate the complexities and contradictions of the technological arena.

The Job

> *"Technologies and scientific discourses can be partially understood as formalizations, i.e., as frozen moments, of the fluid social interactions constituting them, but they should also be viewed as instruments for enforcing meanings." (Haraway, 1991, p. 164)*

I generally begin interviews with research participants by asking what their jobs are, in a nutshell, and where they personally place their emphasis. The women I have talked with have answered by giving their job titles and summarizing their job descriptions or responsibilities, and by situating their work within a hierarchy of functions in their companies. But they do not seem to be able to articulate goals/foci/emphases of their own. Their own personal agency seems to have blurred with 'the good of the company.' Marie put it this way: "Personally, I place the most emphasis on doing what's good for the company. . . I think that if the company is doing well, I'm going to have a better chance of doing well" (M-1). The women I have interviewed seem to see their computer scientist selves in terms of their roles as serving the company.

Many of the women I have interviewed express satisfaction in getting things done, as opposed to finding satisfaction in being involved in a given effort. Overwhelmingly, I have heard concern with issues of 'doing one's job,' getting programs to run, keeping the company running. They seem to view their worlds in terms of how they (and others) serve the company. Even when asked pointedly, they do not talk about issues of the importance, relevance, appropriateness, worthiness of the activities they engage in on the job, in service of the big company machine. They do without such reflective processes, it seems, in exchange for the security that comes with their high-paying, high-status, high-tech jobs. The following exchange with Tamra (T-2) provides a startling example:

Linda: Do you ever question whether these databases really mean so very much to society, in the big picture?

Tamra: All the time! . . . (then goes on to compare how much time (money) she sometimes needs to spend maintaining certain seldom-used databases, and the revenue generated by the 'two or three' scientists in the entire world she estimates actually use this data).

Linda: Do you sometimes also suspect that the people who do find this stuff valuable might be doing stuff that you wouldn't approve of with that information?

Tamra: I've never thought of that...I've never thought of that...That's an interesting point...I've never thought of that...Boy! That's really something to think of...it really is...

Ironically, while Tamra is not questioning her company's activity in great depth, she seems to be experiencing some discomfort within herself. She is aware this job does not offer everything she wants in a career, though she does not articulate her inner conflict well yet. She takes great satisfaction and pride in her programming work and in her mastery of her realm of computer expertise within her company. She enjoys the detective work of tracking down and correcting the failures of databases she is responsible for. She enjoys contact with the program developers and database designers and managers within her company, as well as the outside vendors and consultants, whose expertise relates to her own responsibilities. She does not feel that, as a woman, she is treated differently than the men. She is pleased to be, more or less, "one of the guys" (T-1).

Recently, however, Tamra has enrolled in an evening program of study in the field of massage therapy, and intends to take the examination for state licensure within the coming year. She wonders if she may be able to find, in a part-time massage therapy job, energy and satisfaction that may fuel her computer science career. She wonders if she may be able to reduce her computer science career to part-time in order to take up a greater involvement in a massage therapy career. She likes the personal feedback that comes with doing massage and helping people feel better. Her computer science job has no remote analog. Still, she likes her computer work, and she does not want to leave the technical realm altogether.

She sees the analytic thinking style she has developed in connection with her technological studies and career as advantageous in her study to become a licensed massage therapist. It is important to her to understand what connects to what in the human body, and what massage techniques effect what bodily organ/system/function/sensation. She notes that other massage students who lack her training in mathematics and science, and who have trouble mastering the formal anatomy and physiology studies in the massage school curriculum, are not necessarily disadvantaged in the clinical, hands-on aspects of the curriculum. Tamra is respectful that other massage students have other legitimate ways of knowing how massage effects the body. She, however, is fond of and dependent upon her own scientific style of thinking about the way massage works; she finds it effective. Tamra is in her twenties.

Marie, in her forties, does not question her company's activity either. She too responded with, "I've never thought of that" (M-3), when asked if she suspects her company's products may be used in ways she wouldn't approve of. She has always thought of her company's work as "benefiting mankind: the intent is good." She has been with her company over 20 years, and expects to stay until retirement. She values logic over emotion in the assessment of situations that call for judgment, decision, or policy making. She is soft-spoken, articulate, and focused. She expresses her logical analyses of situations in well-developed cases, taking care to maintain "consistency" between stated assumptions or values and arguments for expected or desired outcomes.

She is "organized" in the tasks she undertakes, as well as the words she speaks. Her favorite assignments within her company have been in operations. She likes the immediacy of the work there, the ease of measuring productivity, the clarity of the responsibilities to be performed at any given moment in response to messages that appear on the console or in tending to production procedures--either carrying them out or specifying and writing or modifying them to incorporate the relevant company-specific matters with the technical details of the most recent revisions of software and hardware. Marie was first placed in computer operations after she quit college and joined the army. The aptitude tests she took there led to her being trained in computer operations. She believes her tolerance for having a lot of things going on at the same time and her ability to keep all these things on track make her well-suited to the computer operations work she started out in as well as the technical work she is doing now. She thinks this "says a lot about the aptitude testing they do in the army and the military. I mean, I was placed there. I didn't say I would like to go into this."

Amy is in her forties. She left college after the first two years. When she later returned, she changed majors from agronomy and botany to computer science, and put herself through working as a secretary. She came to work with her present company ten years ago, after a five year stint as a computer scientist at another company. She has given grave consideration to the fact that, while her company is not directly involved in environmentally destructive practices or military activity, in which she knows she wants no involvement, there are surely secondary or tertiary connections to such activity, with which her conscience would be uneasy. But people need to make a living, she reasons, so they have to decide where they will draw the line between what they will do and what they will not do. She is able to articulate that, for her, an important part of having her technical job has to do with having feelings of purpose, belonging, and accomplishment. She participates in *society* as a computer science professional, and involvement is vital to her sense of identity and agency, not only in her career, but in life in the broader sense.

Reflections

> *"So my cyborg myth is about transgressed boundaries, potent fusions, and dangerous possibilities which progressive people might explore as one part of needed political work. One of my premises is that most American socialists and feminists see deepened dualisms of mind and body, animal and machine, idealism and materialism in the social practices, symbolic formulations, and physical artefacts associated with 'high technology' and scientific culture. . . Another of my premises is that the need for unity of people trying to resist world-wide intensification of domination has never been more acute. But a slightly perverse shift of perspective might better enable us to contest for meanings, as well as for other forms of power and pleasure in technologically mediated societies." (Haraway, 1991, p. 154)*

On first listening to women's inability to articulate the personal importance of their technical work, I was disappointed. My disappointment turned to disillusionment when I discovered that many had not reflected upon the repercussions *in the world* of the work in which they involve themselves daily for money. As I consider the ways these women view 'the job,' I find cyborg images useful. Marie, for instance, does not feel like a machine part in relation to the jobs in operations. That her role in operations has been one of well-specified, often mechanistic, service to computer systems seems opaque--obvious--to me, while it must be relatively transparent to her. She is willing to become one with the machine, to dance to its rhythms. She is thus effective in the job, and earns personal confidence and corporate decision-making power that may be used in "taking responsibility for the social relations of science and technology" (Haraway, 1991, p. 181). Tamra, as she squirms and maneuvers to find a comfortable and satisfying place from which to work, in her own way, may be squirming and maneuvering, as well, "to embrac[e] the skillful task of reconstructing boundaries of daily life, in partial connection with others, in communication with all our parts" (Haraway, 1991, p. 181). Amy seems aware of a oneness, a complicity, a cyborgian merging with the company machine. Hers may be a spiral dance "suggest[ing] a way out of the maze of dualisms in which we have explained our bodies and our tools to ourselves" (Haraway, 1991, p. 181).

The women computer scientists I study indeed are crossing boundaries, in the sense of Haraway's observation. Not only have they faced down barriers to the realm of the technical, the realm of men's work; they have entered into partnerships with the technological. These partnerships call for their service of and loyalty to their technologies, as well as their knowledgeable, creative, and responsible guidance of the technology. The women enter into this activity, each in her own version of the spiral dance of goddess and cyborg (Haraway, 1991, p. 181), the dance that inspires Haraway and Damarin (1994), among others, to find hope, identity, and meaningful agency in an otherwise all too stifling, technological world culture.

References

Damarin, Suzanne K. (1993). Technologies of the individual: Women and subjectivity in the age of information. In Joan Rothschild (Guest Ed.) & Frederick Ferre (General Ed.), *Research in philosophy & technology, 13: Technology and feminism* (pp. 183-198). Greenwich, CN: JAI Press, Inc.

Damarin, Suzanne K. (1994). Would you rather be a cyborg or a goddess? On being a teacher in a postmodern century. *Feminist teacher, 8*(2), 54-60.

Damarin, Suzanne K. (March, 1995). Technologies, boundaries, and realities: Dancing on the borders of human and machine II: A Deconstructive demi-dance. Paper presented at the annual meeting of the National Association for Science, Technology, and Society. Washington, DC.

Haraway, Donna J. (1991). A cyborg manifesto: Science, technology, and socialist-feminism in the late twentieth century. In *Simians, cyborgs, and women* (pp. 149-181). New York: Routledge.

TECHNOLOGIES, BOUNDARIES, AND REALITIES: DANCING ON THE BORDERS OF HUMAN AND MACHINE III:

THE PARADOX OF TECHNOLOGY FOR PERSONS WITH DISABILITIES

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Assistive technologies that replace or enhance physical abilities or compensate for a disability, change the reality of disabled persons, their families and communities (AOTA, 1994; Cook & Hussey, 1995; *Exceptional Parent*, 1995; Mann, 1991). The assumption is that the "new" reality will be one that is less limiting, more liberating to the person and society and generally closer to the normal end of the ill defined continuum of Able Bodied Persons (Avillion, 1987; Butler, 1986; McCuaig & Frank, 1991; Wikoff, 1995). This assumption is strengthened by such personal experiences as being able to see more clearly through the use of eyeglasses, and is supported by media "miracle" stories of severely disabled children trapped inside their bodies until they learn to communicate through and use a computer or other electronic device. Who can deny the contributions that someone of Stephen Hawking's stature has made, a man who is dependent on technology to speak and move? His great mind can work through technological devices to reach and teach theoretical physics to scientists and laypersons (Hawking, 1988). Thus, it is easy to conclude that the melding of person and machine produces a Super-Cyborg that frees persons with disabilities.

As an occupational therapist working with children who have disabilities as well as working with their families, it has been my perception that the new realities created by these technologies are actually quite complicated, beyond the mere technological, more-is-better fix. For the child and caretaker, the new reality presents paradoxes, trade-offs and boundary riding as a part of this new cyborgian identity.

Examples of Changed Realities When Persons with Disabilities Use Technologies

The cartoonist, John Callahan, expresses some of these issues in his cartoons, considered by some to be politically incorrect, dark humor. In a recent published cartoon (Callahan, 1989) there is a drawing of a sheriff and his posse surrounding an empty wheelchair in the desert. The caption under the drawing reads: "Don't worry, he won't get far on foot." Usually the cliché is written and spoken in old Western movies to underscore the vulnerability of people to the perils of the desert heat. In such a place, human beings are quite dependent (in the cliché for water and a horse). Disabled or not, the owner of the wheelchair in Callahan's cartoon is likely to succumb to the elements; paradoxically, desert heat or not, he is not likely to go far because he can not walk. We laugh heartily at the absurdity in the first instance and pull back in embarrassment as we laugh at the brashness of the second. Yet it is often the startling re-thinking of what it means to have a disability and how technology influences that life space that helps professionals critically view the realities that are framed by technology.

A wheelchair permits mobility of a person who can not walk; it does not give that person job skills nor, in itself, inspire a child to do homework. A person in a wheelchair is not automatically an honest, law abiding citizen, as the absent owner in Callahan's cartoon attests. The Public and the professional alike often make assumptions without listening to the individual stories of changed realities that technologies create.

The two most widely discussed assistive technologies for persons with disabilities are powered mobility (Avillion, 1987; Butler, 1986; Douglas & Ryan, 1987; Fewster, 1990) and computer assisted technologies for school, work and communication. The assumptions are that these technologies are liberating because they empower the individual: that there is more choice in their lives, more ability to act on the world, more opportunity to interact with people. The following three stories tell of ways that the use of technology supports these assumptions while, **at the same time**, goes beyond these boundaries of performance and existence in the lives of these children with disabilities (Ferguson, Ferguson & Taylor, 1992; Pollner, 1987; Wolf, 1992).

Ryan

Ten year old Ryan's social interactions as a result of his new powered wheel chair exemplifies a paradox of technology. A power chair with an extra powerful motor, extra rugged tires and long lasting battery was selected for Ryan. Because he was outgoing and friendly, a primary goal was to enable Ryan to participate with his non-disabled peers at recess, and to engage in playground activities. To achieve the additional power and durability, the chair was large, heavy and cumbersome in the classroom. The new powered chair increased Ryan's socialization by allowing him to be mobile, to move as fast as his classmates and have the stamina to engage in play for the entire recess. At the same time, the chair limited his social interactions; because of its size, Ryan was physically distanced from his peers. The chair literally surrounded (and protected) him...no pushing or shoving, no touching, whispering, nudging. Because of the chair's size and lack of maneuverability in small spaces, Ryan required a special desk, large enough to clear the height of his wheelchair, to be placed just inside the classroom door, separated from the group, as well as from close contact with the teacher. He was alone and on the margin of the classroom experience.

Other issues of paradox were observed when Ryan got his new chair. Because he was quite limited physically, he was unable to manipulate his non-powered wheelchair. With his new chair he became more independent in mobility. However, the battery would run down, wires would disconnect and the chair was not in working order often enough that his disability could not become less visible because of the technology. He was more dependent when his chair was non-functional than when he was in his old, manually driven chair. His new chair was too heavy for classmates or most adults to push, resulting in a "stay where he was placed" situation. Although this occurrence would happen only once a week or once a month, it was a reminder to all of Ryan's disabilities, disabilities that had become more invisible when he was functioning as an able student and playmate at school.

Jacob

Jacob was a kindergarten student in a special education classroom. He was dependent in his care and was unable to talk. He used his big, brown, expressive eyes to communicate basic needs, emotions and social interactions. He smiled and made eye contact for "yes" - stuck out his lower lip and looked at the speaker for "no" - turned his head away to show displeasure - looked at what he wanted and smiled - cried, laughed and yelled to express emotions. His family and professionals felt he would be able to communicate a wider and deeper range of thoughts and ideas with an augmentative communication device. The 12" x 18" electronic box attached to his wheelchair. It could be programmed to "speak" in a synthesized voice and had the capability to allow Jacob to communicate a wide range of requests, reactions and replies. First the device needed to be programmed, and Jacob needed to learn how to access it through a switch to a scanner on the display board. Jacob and all those who worked with him needed to be trained in its complicated use. Teachers, therapists and aides began paying more attention to the technology than to Jacob. They focused on learning to use it, trying to program it, complaining about it's cumbersome size and intrusion in the classroom. What was designed to increase communication ironically did the opposite. The other children, it should be noted, continued to interpret for Jacob by watching his eyes and his face (until he stopped communicating much at all...as if it was too difficult to do so).

Latisha

Latisha is a girl with a disabling condition that influences her muscle tone to the extent that her body is quite contorted through the imbalance of movement and position. In order to prevent deformities and to facilitate the minimal amount of voluntary movement of which she is capable, adapted seating devices were provided for her. These devices held her straight with pads, straps and harnesses, freeing Latisha's caretakers from holding her with their hands, arms and bodies. The positioning devices were designed to normalize her muscle tone and appearance (and, hopefully allow her to have more movement and independent function). However, her mother felt that the seating and positioning devices drew attention to Latisha, saying that it made her look more handicapped than she did in less adapted chairs. Latisha's mother had a low "technology tolerance" and asked that all the chairs, wedges and bolsters be removed from her home. Another reality had also surfaced. While the positioning devices promoted participation in some normalizing childhood activities, it prevented the physical intimacy that holding her child provided for Latisha's mother (Gunther, 1989).

Implications of Critique

It must be emphasized that these stories are not reported here in an effort to demean or denounce technology for children with disabilities. Within the same contexts from which these narratives emerged there are stories of a child who "came out of her shell" (Wikoff, 1995) when she first used a power wheelchair, a child who began to talk when seated therapeutically and technologically, of a child who immediately was able to produce written stories when using a word processor instead of a pencil, children who could ski, bowl or engage in sports, given the proper adapted technique or technology.

The question of "why?" use technology is rarely countered with the question of "why not?". Rarer still is there critique to examine the new realities that are constructed through the technology. It can increase social contacts and, at the same time, decrease intimacy. Its use can empower and enable function at work and at home and, at the same time, give a feeling of impotence due to the dependency on well maintained equipment; it may liberate people to participate in the mainstream of society and, at the same time, constrict their participation to prejudged, acceptable roles and "knowing their place" in society.

Through a critique of technologies, it is hoped that informed designers and providers of technology, those who select and train others in the use of technology, as well as the disabled population and their communities, will be more aware of possible realities provided by assistive technologies that go beyond the traditionally assumed roles and boundaries of persons with disabilities.

References

American Occupational Therapy Association (1994). Alliance for Technology Access. In *Technology Special Interest Newsletter* (4)3.

Avillion A. (1987). Barrier perception and its influence on self esteem...wheelchair-bound individuals. *Rehabilitation Nursing*. Sept-Oct 11(5) 11-14.

Butler, C. (1986). Effects of powered mobility on self-initiated behaviors of very young children with locomotor disability. *Developmental Medicine and Child Neurology* (28), 325-332.

Callahan, John. (1989). *Don't worry, he won't get far on foot*. New York: Vintage Books.

Cook, Albert & Hussey, Susan H. (1995). *Assistive technologies: Principles and Practice*. St. Louis: Mosby.

Douglas, J. & Ryan M. (1987). A pre-school severely disabled boy and his powered wheelchair: a case study. *Child: Care, Health and Development*. (13) 303-309.

Exceptional Parent. 1995 Resource Guide. January. 25 (1).

Ferguson, Philip M., Ferguson, Dianne L., Taylor, Steven J. (Eds.) (1992). *Interpreting disability: A qualitative reader*. New York: Teachers College Press.

Fewster C. (1990). Wheelchair apartheid. *Nursing Times*. June; 86 (23) 49-51.

Gunther, Linda (1989). Personal communication.

Hawking, Stephen. (1988). *A brief history of time: From the big bang to black holes*. New York: Bantam.

Mann, William C. & Lane, Joseph P. (1991). *Assistive technology for persons with disabilities: The role of occupational therapy*. Rockville, MD: The American Occupational Therapy Association.

McCuaig, M. & Frank, G. (1991). The able self: Adaptive patterns and choices in independent living for a person with cerebral palsy. *American Journal of Occupational Therapy* 45 (3) 224-234.

Pollner, Melvin. (1987). *Mundane reason: Reality in everyday and sociological discourse*. New York: Cambridge University Press.

Wikoff, Marilyn (1995). Personal communication.

Wolf, Margery. (1992) *A Thrice-told tale: Feminism, postmodernism, and ethnographic responsibility*. Stanford: Stanford University Press.

TECHNOLOGIES, BOUNDARIES, AND REALITIES: DANCING ON THE BORDERS OF HUMAN AND MACHINE IV:

YELLOW ROSES: THE CASE AGAINST THE NAME 'VIRTUAL REALITY'

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> *Then came the revelation. Marino saw the rose as Adam might have seen it in Paradise. And he sensed that it existed in its eternity, and not in his words, and that we may make mention or allusion of a thing but never express it at all; and that the proud, golden tomes that cast a golden penumbra in an angle of the drawing room were not--as he had dreamed in his vanity--a mirror of the world, but simply one more thing added to the universe.*
>
> - *Jorge Luis Borges,* A Yellow Rose

The dream of totalizing representation, as Borges (1967) reminds us in his essay, is an enduring part of our vanity. Beyond the service of the ego, the promise of full representational isomorphism to the physical or natural world is the ontology of science. And beyond science, the ideas of absolute unity and complete similarity feed notions of racial politics and the acquisition of absolute power.

Both the name and the promise of 'virtual reality' capture our imagination. The idea of creating worlds drives both poet and politician, the corrupt and the hopeful. To create worlds with such fidelity to our own that they would be, to all practical purposes, indistinguishable, goes even beyond the hope of Borges' dying poet of the rose--who only saw his works as a 'mirror' of the world.

'Virtual reality' beckons the dreamer forward, engages the imagination, and promises the 'resurrection of the glorified body' envisioned by the biblical writers for the 'body' of our human society, following the death of the diseased and corrupted body of current society. On the personal level, many writers and thinkers about 'cyberspace' want to 'download themselves' into this 'virtual world', thereby escaping the 'fundamental anxiety' of Alfred Schutz--the knowledge of their own certain, impending physical death (Schutz, 1962; Stone, 1991).

It would be futile to deny the technologies that travel today under the name of 'virtual reality'; they exist, and will grow in sophistication and number. It would likewise be futile to deny human longing for rebirth, control, immortality, power--the ability to 'remake the world closer to the heart's desire'--these things exist as well.

What can be thought through is the essential revelation given to Borges' dying poet--that the representation of a thing is something that we add to the world, not a replacement, improvement upon, or isomorph of the thing itself. In this thought, we would resist what Baudrillard has called 'the precession of similacra' (Baudrillard, 1991a), we would interrupt the distancing of technologized views of the world from human ones, and we would retain for our protection some sense of disbelief that the words 'virtual reality' would have us abandon.

Who Brought 'Virtual Reality' into the World? The CyberStork?

The history of people repeats the theme of the miraculous coming of a being (or 'systembeing') that will liberate people from the consequences of a linear, cause and effect world. The coming of this being almost always promises an edited reality, similar or intensified in its' reproduction of earthly delights, but disburdened of the unwanted and allowing instant access to the wanted- and in infinite variety and repetition. Most of all, the new and improved state brought about by being/systembeing makes obsolete the linear, the time-linked, the constrained--the terrible burden of having to make the immediate next choice, and wait for one of a thousand possible "nexts", or perhaps waiting forever and receiving no response.

In such cases, historically, it has been useful to provide the being with both an origin myth and a significant name. The origin myth helps provide the right degree of approachability, while preserving the notion of "otherness" which is so vital to an eventual belief in the power of the being. Sometimes, the origin myth helps hide or distort a part of the story which would be inconsistent with the intention of the mythmakers. The name has often helped crystallize and image the core belief desired about the being, or one of its attributes.

So where did 'virtual reality' come from? The CyberStork? A first mythic answer is found in the following excerpt:

> By 1984, the year of *Neuromancer*'s publication, personal computers were starting to appear on desks all over the country; computerized videogames had become commonplace; networks of larger computers, mainframes and minis, were becoming more extensive and accessible

> to people in universities and corporations; computer graphics and sound were getting interesting; huge stores of information had gone online; and some hackers were changing from nerds to sinister system crackers. And of course the rate of technological change continued to be rapid--which in the world of computers has meant better and cheaper equipment available all the time. So computers became at once invisible, as they disappeared into carburetors, toasters, televisions, and wrist watches; and ubiquitous, as they became an essential part first of business and the professions, then of personal life.
>
> Meanwhile the global media circus, well underway for decades, continued apace, quite often feeding off the products of the computer revolution, or at least celebrating them. The boundaries between entertainment and politics, or between the simulated and the real, first became more permeable and then--at least according to some theorists of these events--collapsed entirely. Whether we were ready or not, the postmodern age was upon us. (Maddox, 1992)

In constructing this prior history of what he will go on to name as cyberpunk and 'virtual reality', Maddox neatly moves his story from the particular to the global, and from the easily provable to the conjectural. In many of the origin myths about technology, its inevitability is shown by the selection of narrated events; its inevitable future is demonstrated by 'extrapolation' from such histories.

In the same way, 'virtual reality' is given credence by a recounting of the history of computing that focuses on successful imitation of certain highly bounded experiences or interactions. By a recounting of Turing tests, Chinese rooms, and other simulation successes, an extrapolated future is given credence. Invocations of Hollywood (Neuromancer, Blade Runner), space and aviation successes, and interviews with 'VR's' scientific parents all add to the mythologic origins--while the implementation of 'VR' games give the individual approachability required for the believer.

As to the name 'virtual reality', not everyone is comfortable with this name:

> Some people object to the term "Virtual Reality", saying it is an oxymoron. Other terms that have been used are Synthetic Environments, Cyberspace, Artificial Reality, Simulator Technology, etc. VR is the most common and sexiest. It has caught the attention of the media. (Isdale, 1993)

Inquiring into 'Virtual Reality'

I am not indifferent to *what* technology means, in the sense of having a philosophical or theoretical standpoint. I simply think that *how* technology means is also a critical place to look....the workings of the actual, everyday, taken-for-grantedness of technology in our interaction with it and each other....as documented in a "thick description" of actual lived experiences of technology, as free of preconceptions as possible. Such description, freed from theory, philosophy, and the intentional "spin" of culture (especially through jargon) might provide additional, fruitful places for critic, theorist, or believer to originate a rethinking.

"This is some sort of phenomenological look at technology", you might think, and I would say that you are right. It owes an intellectual debt to Edmund Husserl's phenomenology (Husserl, 1962) , hoping to see how the organization of our experience of some piece of technology constitutes its reality. "To the things themselves," was the cry of the phenomenologists--not to their names, their categories, their theories or philosophies, but to the pure stratum of experience of the things themselves for our studies, ruthlessly suspending or, as Husserl called it, "bracketing out" all other considerations. I propose a more mature version of phenomenology, that does not need to ruthlessly bracket out all cultural or philosophical framework.

The example I will talk about in this paper is that of what has come to be called "virtual reality"--and how we might investigate and study it by phenomenology with a twist. It would be possible to have an entire conference on how the various philosophies of reality apply to computer simulated 'worlds'. In such a conference, papers would be given on ancient Greek views of reality, Cartesian theses of sense reality, Husserl's 'natural attitude', and--no doubt--two days would be set aside for postmodernists to prove that there is no reality, virtual or otherwise. A lively week of debate would be had about the nature of reality, after thousands of years of thought in hundreds of cultures. At the end of the day, no one would agree on what Aristotle called "real reality"--much less upon what would constitute something "virtually the same".

It is exactly that debate which, in my view, would first require "bracketing" in the Husserlian sense....suspension, or a deferment to another time. I want to describe boundaries, contested areas, junctures in technology from the point of their being experienced in the lives of people instead of from philosophy, language or theories.

Here's a swift look at the point.

You are taken to a room, humming with electronic noise. A strange chair, much like a dentist's chair, sits in the center of the room. Having been asked to sit, you are invested with an 18 pound headset containing CRTs and other electronics, your feet are placed precisely on two pedals and strapped down, and both of your hands are inserted in gloves which, though you cannot see them, feel like they are not only fully wired within but also attached to cables or tethers.

In your headset, images flicker to life and you appear to be driving an automobile down a fairly lifelike, but still vaguely cartoonish road.

You have never heard the term "virtual reality". What would you call this experience you just had, if you were on your own to name it? If you then heard it called "virtual reality", what would make you accept that name--and what shifts in your thinking would be required to accept that name? If you were trying to sell this system and make money, what would you call it, and why would you think that one name would sell better than another?

"It was almost like being there," has been said in many places. "Cinema space" has been analyzed by Alexander Sesonske and others in an attempt to define how we are able, and more importantly willing, to be in a state where "the slightest invitation will persuade us to abandon our ordinary lives and live wholly within the world of the film" (Sesonske, 1972). Michael Heim, in his book *The Metaphysics of Virtual Reality* (1993), says that stories of virtual reality "suggest our need to create realities within realities, to suspend our belief in one set of involvements to entertain another...our ability to enter symbolic space".

My point here is that the term "virtual reality" may be, if one is looking at the practicalities of using the technology, a term contrived for its instrumentality in facilitating the suspension of human disbelief necessary to enter a newly contrived experience which the contrivor wishes to have taken-as-real. The term "virtual reality" may be encouraging us to ignore our individual experience of the technology--organizing in advance, by virtue of a name, the reaction that we "should" have to this newly contrived environment.

If that is true, it places on the table some questions, not the least of which is "To whose benefit is it that we enter a so-named symbolic world"? If the term virtual reality is a contrivance, if it is a working-tool, if its chief asset is that it helps overcome disbelief or the impediments to acceptance created by the technology itself, if it creates the "exemplification of a property of experience in the absence of any experience" (Hacker, 1989, p.135), whose is it and what purpose does it serve?

The various origin citations of the term 'virtual reality' connect it to popular literature and to scientists working in media labs. However, following these same citations leads quickly to the fact that much commerce has followed virtual reality technology and the interest in it. Here is where, in my opinion, the phenomenological reduction will not hold. It is appropriate, and vital to understanding, not to decontextualize the phenomenon of VR to the point where it cannot be seen that someone stands to gain more from one name for a technology than another.

I believe that naming, as demonstrated by the discussion of virtual reality, is one method by which technology becomes invisible and the desires of technologists are hidden--and by which our thinking and study about technology is channeled away from fruitful studies.

Emerson, Lake and Palmer used a phrase in a song that I always think of when I think of the "willing suspension of disbelief in the facticity of the everyday world" that Husserl and his successors believe constitutes our "natural attitude" of dealing with the world. This song contains a wonderful phrase--" the opium of custom"(Emerson, Lake,,& Palmer, 1977). Undoubtedly, the study of the boundaries between human and machine, much less any 'dancing' taking place on them, is made terribly difficult by the numbing of thought encouraged by our culture.

To me, our natural attitude is not an entirely voluntary suspension of our disbelief...to me it is promoted by economic, political and other systems of belief, leveraging us through culture and through our personal desires. Part of the so-called "natural attitude" is not natural in any sense--it is slowly and relentlessly addictive, and can only be given up with difficulty. I do not dispose entirely of the notion of natural attitude, but I do think that in our quest to find and deal with the borders of human-machine interaction, that we are partially "under the influence" of the opiate of our technological culture. Here again, the complete bracketing of culture will not do if we are to truly investigate the phenomenon of technology.

How, then, to do it? What sort of study can be made to find the boundaries, avoid the many philosophical pitfalls of defining reality, virtuality, perception and truth, and take into account cultural and societal pressures and influences without moving wholly into critique?

I believe that a form of phenomenological inquiry into technology would be fruitful--a form of phenomenology radically changed from its beginnings, and bearing some relationship to the so-called strong programme in sociology or the feminist science derived from the "standpoint epistemology" proposed by Sandra Harding and others (Harding, 1993, 1991).

In this inquiry, the boundaries of human and machine would be studied from a starting-point in the full richness of the lived world of that human being, and with full cognizance of the position of that starting point in culture and society. The observer, while attempting the 'thick description' beloved of ethnography and the elaboration of the essential elements of the phenomenon, would still retain her/his identity and connections. If you will, a sort of 'standpoint phenomenology'(Smith, 1987).

Some studies exist where glimpses of this benefit can be seen. In the work of Michael Lynch, such as in *Art and Artifact in Laboratory Science* (1985), we have for the first time a thick description of humans as they develop their interpretations and integrations of "things" generated by a machine. In Lucy Suchman's *Plans and Situated Actions* (1987), the actual experience of people as they negotiate an interface with a machine is presented. These are ethnomethodologic studies, standing firmly on their minute focus on the interactional methods themselves.

What I am perhaps proposing is that these types of studies be done in new and 'standpoint significant' locations--imagine if you will having studies describing the lived experiences of marginalized people with technologies such as the so-called virtual reality. What language would they use? What would be their experience of it? What would be their fantasy of its future?

Technology itself is returning to a fascination with the body, and the so-called virtual reality is one symptom of this diagnosis--though it is not clear whether that fascination involves complete phenomenological immersion of the body or its replacement, or both. In the same way, I think that the study of the boundaries of humans and machines must add to the abstractions of theory, philosophy and criticism a more grounded, embodied study....one that deals in events and their contexts, generating accounts that can be used by all.

My colleagues have spent time at these boundaries, looking at them and the people who live on them by the strong light of various theories and philosophic commitments. This is not an indictment of those methods, but a simple methodological addition. It is rather to say that, phenomenology and its methodological descendants, conversation analysis, ethnography and ethnomethodology, might be combined with their particular contextual awareness into yet another useful method of inquiry.

I am interested in how technology comes to have meaning for people--and a modified phenomenology provides for me a method to study that technology by a means that never threatens, through categories, languages, philosophies, or systems, to become a technology in and of itself.

> *"We do not call them virtual for no reason: for they maintain thought in indefinite suspense, linked to the deadline for exhaustive knowledge. Here, the process of thought is indefinitely postponed. The question of thought can no longer be asked of them, nor the question of freedom for future generations: they will cross over life as if it were airspace, fastened to their seat. " (Baudrillard, 1991b).*

We have been given to believe that the CyberStork brought us 'virtual reality'. In not examining the origin of this technology, its naming, or its claimed future, we are accepting 'virtual reality' as mythologically, if not miraculously conceived. I am not arguing against the technology, but against a blind belief about/in that technology. Unlike Nagel's argument, that we can never actually, completely know what it is like to be a bat from the point of view of the bat (1974), we can know about 'virtual reality' because it is not 'other'. It is us.

In accepting the name, 'virtual reality', we are accepting that this newly contrived technology is somehow different--to twist Borges' words, it IS a mirror of nature, and NOT one more thing added to the world. We rocket back to a correspondence theory of reality without a hint of discussion, and give to this one avenue of technology a pride of place in our categorizations of the world that it has only claimed, not earned.

An eminent horse surgeon of my acquaintance once told me how he managed to operate on the greatest racehorses of his time with an unmatched record of success; "My father always told me--one horse is the same as another, treat them all alike," he said. In the same spirit, I believe we should treat all technologies with equal critique--not allowing myths, contrivances, wishes or namings to intervene in our inquiry and judgment.

It is vital that we ask Baudrillard's questions of thought and freedom, and act with Borges' warning --that it is all too easy to make mention or allusion (or naming, or categorizing), and never express a thing at all. Only in the vanity of some is 'virtual reality' a mirror of the world--for us, it should be one more thing added to the world; value (or virtue) yet undecided.

References

Baudrillard, J. (1991a). The Precession of Simulacra. In Hlynka, D. and Belland, J. (Eds.) *Paradigms Regained: The Uses of Illuminative, Semiotic, and Post-Modern Criticism as Modes of Inquiry in Educational Technology.* Englewood Cliffs, NJ: Educational Technology Publications.

Baudrillard, J. (1991b). *Xerox and Infinity.* Pittsburgh, PA: Subterfuge.

Borges, J. (1967). A Yellow Rose. In *A Personal Anthology.* New York: Grove Weidenfeld.

Emerson, Lake and Palmer. (1977). Closer to Believing. *In Works:Volume One* (Audio Recording). New York: Atlantic Recording Corporation.

Hacker, S. (1989). *Pleasure, Power and Technology: Some Tales of Gender, Engineering and the Cooperative Workplace.* Boston: Unwin Hyman.

Haraway, D. (1991). A Cyborg Manifesto: Science, Technology and Socialist Feminism in the Late Twentieth Century. In Haraway, D. *Simians, Cyborgs and Women: The Reinvention of Nature.* New York: Routledge.

Harding, S. (1993). *The Racial Economy of Science.* Bloomington: Indiana University Press.

Harding, S. (1991). *Whose Science? Whose Knowledge?* Cornell: Cornell University Press.

Heim, M. (1993). *The Metaphysics of Virtual Reality.* Oxford: Oxford University Press.

Husserl, E.(1962). *Ideas: General Introduction to Pure Phenomenology.* Translated by W. R. Boyce Gibson. New York: Collier Books.

Isdale, Jerry. (1993). *What is Virtual Reality: A Homebrew Introduction.* Isdale Engineering, isdale@well.sf.ca.us.

Lynch, M. (1985). *Art and Artifact in Laboratory Science: A study of shop work and shop talk in a research laboratory.* London: Routledge and Kegan Paul.

Maddox, T. (1992). After the Deluge: Cyberpunk in the 80's and 90's. In *Thinking Robots, an Aware Internet, and Cyberpunk Librarians,* Miller, R.B. and Wolf, M.T., Eds. San Francisco, CA: American Library Association.

Nagel, T. (1974). "What is it like to be a bat?" *Philosophical Review,* 83.

Schutz, A. (1962). *Collected Papers I: The Problem of Social Reality.* Edited by Maurice Natanson. The Hague: Martinus Nijhoff .

Sessonske, A. (1973). Cinema Space. In Carr, D. and Casey, E. (Eds.), *Explorations in Phenomenology.* The Hague: Martinus Nijhoff.

Smith, D. (1987). *The Everyday World as Problematic: A Feminist Sociology.* Boston: Northeastern University Press.

Stone, A.R. (1991). Will the Real Body Please Stand Up?: Boundary Stories about Virtual Cultures. In Benedikt, M. *Cyberspace, First Steps.* Cambridge, MA: MIT Press.

Suchman, L. (1987). *Plans and Situated Actions: The problem of human-machine communication.* Cambridge, UK.: Cambridge University Press.

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SPECIAL EVENTS FOR 1995

CONFERENCE EVE PLENARY:

"Democratizing R/D Policy Making"

- **Edward E. David, Jr.**, Former Science Advisor to the President, Former President of Exxon Research
- **Robert S. Walker (R-PA)**, Chair House Science Committee

Thursday, March 2, 7:30 PM

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EARTH STEWARDSHIP SYMPOSIUM

Jointly Sponsored by North American Coalition on Religion and Ecology

- **Senator Gaylord Nelson**, Founder of Earth Day

Plenary 3: Saturday, March 4, 9:10-10:10 AM

THE ROBERT RODALE LECTURE

"Negawatts and Hypercars: Saving Energy and the Earth for Fun and Profit"

- **Amory Lovins**, Director, Rocky Mountain Institute

Saturday, March 4, 8:30 PM

Support by Calvert Social Investment Fund

THE INCOGNITI TRUST LECTURE

"Social Ecology of a City"

- **James Rouse**, Founder-Chair, The Enterprise Foundation

Sunday, March 5, 11:00 AM

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Paper Sessions: Saturday and Sunday, March 4-5, 1995
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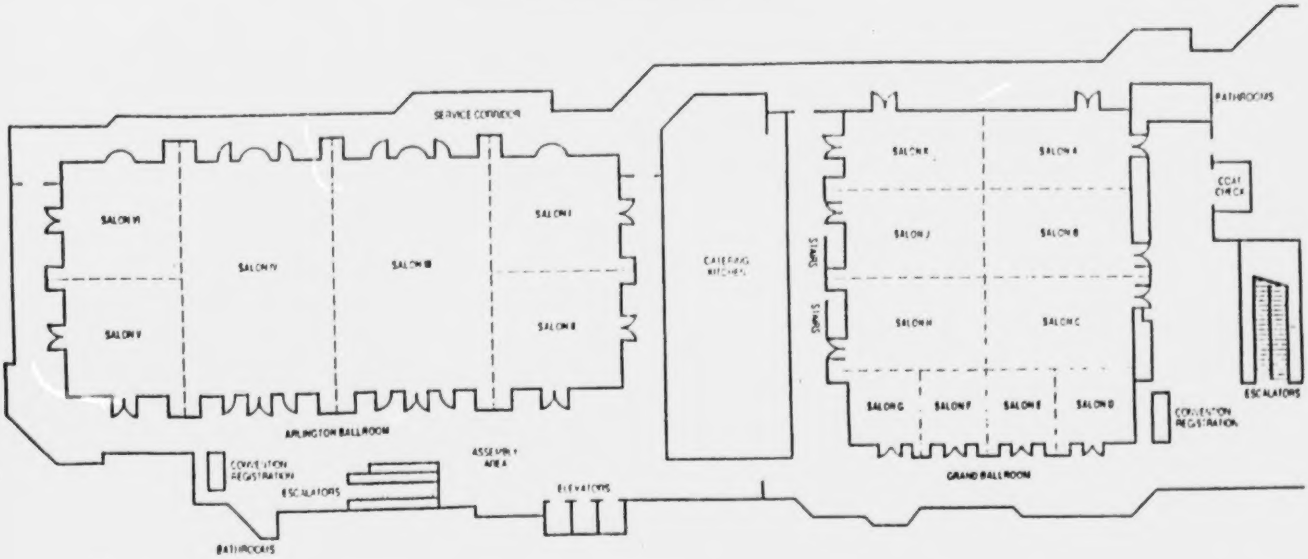
HOTEL MAP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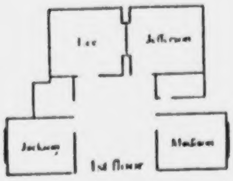
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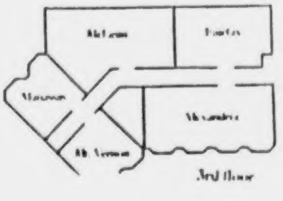
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FINANCIAL SUPPORTERS OF THE TENTH NATIONAL STS MEETING

We wish to thank the following organizations for their financial support of this year's conference:

Calvert Social Investment Fund, originators of socially responsible investing, for their support of the Robert Rodale Lectureship for the past four years

Cray Research Foundation, a Fortune 500 manufacturer of supercomputing systems for business, government, and education, for the support of the annual Dessert Reception

Hoosier Magnetics, Inc., manufacturer of magnetic raw materials (ferrites), for the support of the Engineering and Applied Sciences Symposium for the past three years

MASCO Corporation Charitable Trust, for their sponsorship of the Engineering and Applied Sciences Symposium for the past two years

Incogniti Trust, a private foundation which serves as a Venture Fund for innovators in public service, for their sponsorship of the Lectureship in Science, Technology and Religious Values for the past three years

NATIONAL ASSOCIATION FOR SCIENCE, TECHNOLOGY AND SOCIETY

PRESIDENT: **Ann Mintz**, Orlando Science Center

STS-10 CONFERENCE COMMITTEE:

Jane Konrad, NASTS Vice President and Conference Chair; and Executive Director, Pittsburgh Regional Center for Science Teachers
Victor A. Stanionis, Exhibits, Iona College
Beverly Nelson, Exhibits, Hackensack High School

STAFF:

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ORGANIZATION

The National Association for Science, Technology and Society (NASTS) was formed in 1988 to bring together the increasing number of persons and groups actively concerned with STS. In some ways, NASTS is a federation of already existing sectors of interest: K-12 educators; post-secondary educators; policy makers; scientists and engineers; public interest activists; museum and science center staff; religion professionals; members of the print and broadcast media; and participants from the international community. NASTS's goal is to provide a forum where members of these sectors can gather and take the pro-active stance to guide science and technology as reflections of our underlying values. NASTS seeks to provide the venue for all its members to meet as equals to discuss, debate, and share concerns for society's handling of science and technology. NASTS is organized as a 501(c)3 non-profit educational corporation. Its president and 15-member board of directors, elected by the membership, guides a staff consisting of a Corporation Chair, Members Services Director, and Support Staff. Its address is 133 Willard Building, University Park, PA 16802, Phone 814/865-3044, FAX 814/865-3047.

STS-10 REGISTRATION AND INFORMATION

Conference Registration Desk, Arlington Foyer, First Floor

Thursday, March 2	**6:00 PM - 9:30 PM**
Friday, March 3	**7:30 AM - 5:00 PM**
Saturday, March 4	**7:30 AM - 5:00 PM**
Sunday, March 5	**9:00 AM -12:00 PM (info only)**

BREAKFAST, LUNCH & DINNER SUGGESTIONS

In the hotel, the **Terrace Restaurant** (level 1) serves breakfast, lunch and dinner. The **Atrium** (foyer level) also serves food and drink.

There is an underground mall at the hotel, "The Crystal City Underground," where you will find seven fast food lunch and early supper places at the **Food Court**.

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HOTEL SERVICES:

Shuttle Service: Complimentary van service is available every 15 minutes to and from National Airport, starting at 6:00 AM and running until 11:00 PM. The metro stop is located less than five minutes from the hotel via an underground walkway.
Indoor pool: Located on the lobby level of the hotel; open from 6:30 AM-9:30 PM daily.

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SUBMISSION OF PAPERS

All presenters are urged to place 2 copies of their papers in the box near the registration table marked "STS-10 Proceedings." One copy will be given to the editor of the *Bulletin of Science, Technology and Society.* The other copy will go to the editor of the Annual STS Proceedings which are submitted to the ERIC documentation and retrieval system. Papers not ready at the Conference can be mailed to the appropriate editors. Editors addresses:

Editor, STS Press, 102 MRL, University Park, PA 16802

ERIC: Dennis Cheek, Rhode Island Dept. of Education, 22 Hayes St. B-4, Providence, RI 02908.

ADDITIONAL NASTS HIGHLIGHTS

Friday March 3:

Smithsonian Field Trip, "Science in American Life" Exhibit, the Museum of American History, 11:30 AM-12:30 PM

Exhibit Area - Friday and Saturday, Salon VI

Board Meeting, 6:45-8:45 PM, Fairfax Board Room

Dessert Reception, 8:45-10:00 PM, Salon I & II

Saturday March 4:

Institutional Members Advisor Council Breakfast
7:00-8:00 AM, Lee Room

Education Assembly Breakfast
7:00-8:00 AM, Jackson Room

International STSers Breakfast
7:00-8:00 AM, Jefferson Room

Celebratory Dinner Program
6:30-9:30 PM, Salon I

NASTS Members Meeting
9:40-10:40 PM, Salon VI

Sunday March 5:

STS-11 Planning Meeting
12:30-3:30 PM, Lee Room,
Open to All Interested NASTS Members

International STS Planning Meeting
2:30-6:30 PM, Alexandria Room

Triangle Coalition Meeting
8:00 AM-6:30 PM, Fairfax Room

CONFERENCE EVE PLENARY:

Thursday March 2, 7:30-9:30 PM

Location: Salon 1

Democratizing R/D Policy Making

Chair: **Rustum Roy**, Corporation Chair, NASTS

Edward E. David, Jr.
Former Science Advisor to the President,
Former President of Exxon Research:
"A Realistic Scenario for U.S. R&D "

Robert S. Walker, (R-PA)
Chair, House Committee on Science:
"A Congressional Perspective"

Democracy, The Third Wave in R&D Policy

•

Richard Sclove, Loka Institute; **Wilbert Lepkowski**, C&EN;
Al Fritsch, Science in the Public Interest;
Kevin Aylesworth, Young Scientists Network
Discussion from the floor.

PLENARY 1:

Friday March 3

8:15-10:30 AM

Location: Salon VI

Welcome: **Ann Mintz**, NASTS President (8:15 AM)
Introduction: **Jane Konrad**, NASTS Vice President and Conference Chair (8:20 AM)

Part 1: **Opening Address:** *"The Impact of High Performance Computing and Communications on K-12 Science Education "* (8:30-9:20 AM)

Speaker: **Bill Linder-Scholer**, former Director of Community Affairs, Cray Research Inc. & Executive Director, Cray Research Foundation

Part 2: **Focused Response:** "Reaching the Majority with Science and Technology" (9:20-9:45 AM)

Speaker: **Sue Rosser**, Women's Program Office, NSF

Part 3: **Community Breakouts:** (9:50-10:30 AM)

- Education: K-12 and Post Secondary [Salon VI]
- History, Sociology and Philosophy of Science [Jefferson]
- Applied Science, Technology and Engineering [Jackson]
- Ethics, Values and Religion [Lee]
- Public Policy [Madison]

BEST COPY AVAILABLE

Session 1: Friday, March 3
10:40 - 11:40 AM

Special Session: Friday March 3
Leaving Crystal Gateway Marriot at 10:40 AM

Smithsonian Field Trip, "Science in American Life" Exhibit
Location: Smithsonian Museum of American History
11:30-12:30 AM

One-hour docent-lead education tour and preview of materials in the Hands-On Science Center. Limited to 35 individuals; Sign up at Conference Registration Desk

Leave hotel at 10:40 AM and walk through Underground
to Metro to "Smithsonian Metro" stop.
Meet at the Mall Level information desk of
Smithsonian Museum of American History at 11:30 AM.
Travel time on Metro approx. 20 minutes.

During Session 3 this afternoon, NASTS President Ann Mintz will lead a Roundtable discussion. See Session 3.9: Friday, March 3, 2:10-3:10.

1.1 Panel Environment Alexandria

Community Sustainability

An overview of the discipline of community sustainability and review of some examples of appropriate applications of science and technology in agriculture, energy, education, and community groups such as co-operatives. The work of the Arlington Community Sustainability Network and the Arlington Food Co-operative will be highlighted.

Sara F. Anderson, Secretary of the Board of Directors of the Arlington Cooperative Organization and **Martin Ogle**, Director of Potomac Overlook Regional Park.

1.2 Panel Ethics & Values Lee

Politics of Knowledge in an Information Society

Rappert: *Whose Knowledge Counts?: Intellectual Property, Farmers' Rights, and the PVPA*; **Cherkasky:** *Knowledge Work, Knowledge-Based Systems, and the Commodification of Expertise*; and **Monberg:** *Electronic Public Space: Polis or Panopticon?*

John Monberg (moderator), **Brian Rappert** and **Todd Cherkasky**, graduate students in the Department of Science and Technology Studies at Rensselaer Polytechnic Institute, Troy, NY.

1.3 Panel S & T Policy / Ethics & Values Jackson

Technologies, Boundaries and Realities: Dancing on the Borders of Human and Machine

Explore issues at the interface of human and machine, examining tensions and anomalies in the ways "cyborgian" identities and lives are constructed by persons in various contexts. Condron: *Women engineers and computer scientists reside on the human/machine boundary as well as the "women's realm" / "men's realm" boundary.* Johnson: *Persons with disability confront the possibility of changing the realities of their disabilities through technology.* Shaffer: *In many cases, the desired and achieved transparency of technology seems like the "natural attitude" of some phenomenologists.*

Suzanne Damarin (moderator), **Linda Condron**, **Janet Johnson** and **Allen Shaffer**, all of The Ohio State University, Columbus, OH.

Session 1: Friday, March 3
10:40 - 11:40 AM (continued)

1.4 Panel STS Research Madison

Rethinking Technology

Participants share their experiences on the 1994 National Endowment for the Humanities Summer Institute on Rethinking Technology: "Philosophical Reflections since World War II," and discuss current directions of their own teaching and research.

Leonard Waks (chair and discussant), Temple University, Philadelphia, PA and Penn State University, University Park, PA; **Achim Koddermann**, SUNY Oneonta, NY; **Jesse Tatum**, Rensselaer Polytechnic Institute, Troy, NY; and **Ann Larabee**, Michigan State University, East Lansing, MI.

1.5 Talk Art & Humanities Salon VI

The Impact of Science & Technology on the Humanities

The poet and science speech writer talks about the impact of science on her poetry and the impact of poetry on her science writing.

Patricia Garfinkle, a poet and science writer and currently is at the NSF.

1.6 Workshop Post Secondary Ed. Fairfax

"Using Interdisciplinary Themes and Concepts: A Constructivist Perspective on Integrating Knowledge about STS"

Research on the science education reform movement and on several innovative programs at the University of South Florida has lead to the construction of a model fro implementing changes in the way we teach science and pedagogy in higher education institutions. The model teaches sciences through a trans-disciplinary problem centered approach.

Barbara S. Spector, Ph.D, University of South Florida and **Thomas LaPorta**, University of South Florida.

1.7 Paper Education Mt. Vernon

10:40 - 11:00 — Jeffrey L. Newcomer, Rensselaer Polytechnic Institute, Troy, NY. *Emphasizing Industry: Perspectives on Capstone Design Courses in Engineering Education. (continued)*

1.7 Paper Education Mt. Vernon

11:00 - 11:20 — Frances K. Bailie, Iona College, New Rochelle, NY. *A Multi-media Approach to Computer Ethics.*

11:20 - 11:40 — David L. Haury, Linda Milbourne, and **Niqui Beckrum**, The Ohio State Univ., Columbus, OH. *The Evolving Electronic ERIC (Educational Resource Information Center) and ERIC Clearinghouse In Science, Math, and Environmental Ed.*

1.8 Paper Environment McLean

10:40 - 11:00 — Paul C. Pawlowski and **Bryan Maser**, WVA Univ., Morgantown. WV, *West Virginia University Electric Vehicle Project: A Sustainable Alternative.*

11:00 - 11:20 — Rick Mrazek, Univ. of Lethbridge, Alberta, Canada, *Harnessing Technology to Understand Our Environment.*

11:20 - 11:40 — John Padalino, Pocono Environmental Education Center, Dingmans Ferry, PA. *National Parks - International Classrooms.*

1.9 Paper STS Policy/Education Manassas

10:40 - 11:00— Todd C. Waggoner, Ph.D., Assistant Professor, Department of Technology Systems, College of Technology, Bowling Green State University, Bowling Green, OH. *Fuzzy Logic as a Basis for a Technology-based Liberal Education Course: A Proposal for a New Direction.*

11:00 - 11:20 — Lynn A. Brant, Department of Earth Science, University of Northern Iowa, Cedar, Falls, IO. *A Required STS Course at University of Northern Iowa.*

11:20 - 11:40 — Richard Deitrich, Penn State University, University Park, PA. *Developing STS Courses for Technically Oriented College Students.*

1.10 Applied Science & Engineering Jefferson

Recapturing Science From Abstractionists

This Symposium continues the Breakout discussion in three ways: (1) Key Role of Applied Science for Non-Scientists: (2) Reports by ASE Societies on New Activities; (3) Planning for Awards for "Science Which Helps Society."

Rustum Roy, Chair, Materials Research Laboratory, Penn State, and NASTS Corporation Chair.

Breakfast, Lunch & Dinner Suggestions

In the hotel, the **Terrace Restaurant** (level 1) serves breakfast, lunch and dinner. The **Atrium** (foyer level) serves some food and drinks.

There is an underground mall at the hotel, "The Crystal City Underground," where you will find seven fast food lunch and early supper places at the **Food Court**.

Session 2: Friday, March 3
1:00 - 2:00 PM

2.1 Panel Environment Jefferson

Linking Global Climate Change Research to Social Needs: Reflections on the US Global Climate Change Research Program

Participants will speak on what they see is needed to link global change research with societal needs. Discussion will follow.

Franz Foltz (moderator), RPI , Troy, NY; **Sylvia Edgerton**, U.S. Global Change Research Program Office, Washington, DC; and **Rick Tiltz**, Formerly on Staff of House Science, Space & Technology Committee.

2.2 Panel Society & Technology Lee

Technology and the Afro-American Experience

The panel will present papers on the impacts on and contributions of African Americans to modern technology.

Taft Broome, Howard Univ.; **Susan Cozzens**, RPI, on leave with NSF; **Paul Shuldiner**, Univ. of Massachusetts; and **Richard Sclove**, Loka Institute.

2.3 Panel S & T Policy Jackson

Rational Speculations in Science and Technology: Risk, Rationality and Vision, Part 1

A 2-Session Panel Discussion. Part 2 in Session 3.1

Rejeski: ***Exploring Future Environmental Risks;*** **Larabee:** ***Critical Intervention: Cultural Studies and STS.***

Darryl Farber (Moderator), STS Program, Penn State University, University Park, PA; Dave W. Rejeski, Office of Science and Technology Policy, The White House, Washington, DC; and Ann Larabee, Michigan State University Critical Interventions.

2.4 Roundtable Pre-college Education Alexandria

Self Sustaining, Artificial Environments: A Thematic, Problem Solving Approach to Interdisciplinary and Coordinated Education

The elegant technology developed by Dr. Walter Adey of the Smithsonian Institution's Marine Systems Laboratory provides the foundation for the development of self-sustaining aquatic and marine environments of virtually any size. Become familiar with the Mid-Atlantic Bay Mesocosm which is currently in place and functioning at Glasgow High School. This twelve by forty foot, self-sustaining biological model represents eight major habitats based on water salt content in a bay/wetland ecosystem. We will discuss the application of this technology and curriculum to your circumstances and will suggest how you can become part of a rapidly growing national network of creative and interested individuals and schools.

Robert H. Gross, Glasgow High School, Newark, DE and **Steven A. Barbato**, Applied Educational Systems, Lancaster, PA.

2.5 Workshop 6-12 Education Madison

Fifty-one Laboratory Activities for an Integrated Science Course

Discussion will focus on the work of the Iona College science faculty in developing materials for students in their Scientific and Technological Literacy program which has been offered for over ten years. The central themes that permeate the laboratory activities are model building, problem solving and critical thinking in the sciences.

Victor A. Stanionis, Iona College, New Rochelle, NY.

Session 2: Friday, March 3
1:00 - 2:00 PM (continued)

2.6 Workshop S & T Fairfax

How to Evaluate Science & Technology Forecasts

This workshop will discuss criteria developed by Coates & Jarrett, Inc., a leading futures research consulting firm, for evaluating forecasts of science and technology. The criteria are based on and expand on their analysis of more than 1,500 forecasts as part of Project 2025, a three-year study on the future of science and technology. Participants will use an evaluation checklist to analyze an excerpt of a forecast. Participants armed with this checklist will become better-informed consumers of science and technology forecasts.

Andy Hines, Coates & Jarrett, Inc., Washington, DC.

2.7 Paper Environment Mt. Vernon

A Critique of Environmental Economics

Mark Sagoff, Director, Institute for Philosophy and Public Policy, University of Maryland, and President of the International Society for Environmental Ethics. *On Certain Problems in Ecological Economics.* Organized by **Eric Katz**, NJIT.

2.8 Paper K-12 Education McLean

Corporations, Colleges, and Curricula: Renegotiating Environmental Education K-12

Washington State University and the Weyerhaeuser Company have entered into an "environmental education partnership" designed to build environmental literacy and education in Washington schools. This partnership focuses on the development of curriculum to meet the needs of comprehensive teacher preparation, so that a balanced approach to environmental education can be assured in K-12 classrooms. *(continued)*

2.8 Paper K-12 Education McLean

(continued)

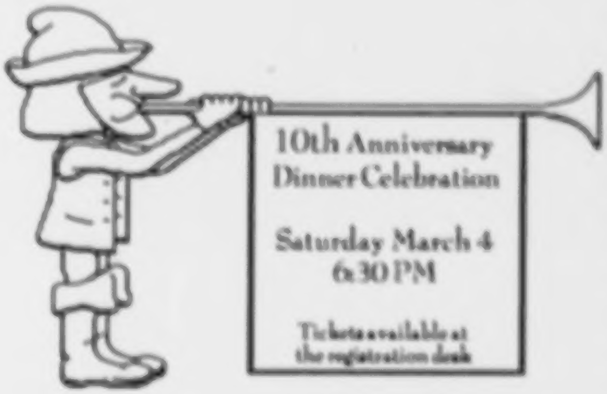
Sharon Chapin, **Kristine Burns**, Washington State University, College of Science, Pullman, WA; **Jack Horne**, **Elizabeth Crossman**, Weyerhaeuser Co. Foundation, Tacoma, WA; and **Martha Avery**, Washington Timberlands, Weyerhaeuser Co., Tacoma, WA.

2.10 Workshop 6-12 Education Manassas

Beyond the Looking Glass: A Virtual Reality Training Project for Mathematics and Science Teachers

Discover how the Virginia Space Grant Consortium and two of its members, the Mathematics and Science Center and the Science Museum of Virginia, came together to produce material that can help teachers make connections between physical science, biology, and mathematical principles. The partners developed a training manual which provides an understanding of virtual reality for use in conjunction with a PBS video.

Presenters: **Patrick Golden**, Program Manager, Virginia Space Grant Consortium and **Bambi Gladfelter**, Curriculum Specialist, Science Museum of Virginia.



Session 3: Friday, March 3
2:10 - 3:10 PM

3.1 Panel S & T Policy Jackson

Rational Speculations in Science and Technology: Risk, Rationality and Vision – Part 2

See Session 2.3 for Part 1.

This session features a response by **Noel Gray** and an **open discussion on Conversations for Citizen Involvement.**

Noel Gray, Penn State, University Park, PA.

3.2 Panel Environment Jefferson

Technology and Natural Disasters

Recent natural disasters – major earthquakes in San Francisco and Los Angeles, Hurricanes Hugo and Andrew, Mississippi River floods – have raised serious questions about human responsibility for overbuilding in disaster-prone areas. This session will explore issues of technological responsibility in this context or human reactions to natural disasters, and of the need for better preparedness in the future.

Paul T. Durbin, Ph.D. (Moderator), Philosophy Department, University of Delaware, Newark, DE; **Joanne Nigg**, Ph.D., Disaster Research Center, University of Delaware, Newark, DE; and **Timothy Casey**, Ph.D., Philosophy Department, University of Scranton, Scranton, PA.

3.3 Roundtable Lee

Technoscientific Knowledge: The Role of Social Movements

The participants of this session seek to expand and deepen the meaning of social constructivism. We present case studies which suggest that technoscientific knowledge is not only shaped by the social, but that social movements, such as the environmental movement, create knowledge. *(continued)*

3.3 Roundtable Lee

(continued)

Taylor: Workers, Environmentalists, and Expert Knowledge: *The Manufacturing of Toxicity and Nature, 1962-1992.* **Lucena and Downey:** *Engineering Selves.* **Crumpton:** *Environmental Justice and Popular Epidemiology: Redefining the Science of Public Health.* **Obregon:** *From a Damned Tree to A Curable Disease: Lessons From the Stigmatization of the Body.* **Njambi:** *AIDS in Africa: The Construction of Scientific Promiscuity.*

Douglas Taylor, Juan C. Lucena, Gary L. Downey, Amy Crumpton, Diana Obregon, and Wairimu Njambi, STS graduate students, Virginia Polytechnic Institute, STS Center, Blacksburg, VA.

3.4 Workshop 6-12 Education Madison

Marine Science at Work: Youth Action Plans

Marine Science at Work is a new Cornell Cooperative Extension publication for both formal and informal educators to help youth learn that science is relevant to their lives, and is working to solve problems that affect them. The workshop will explain the issues and research, and demonstrate the youth activities. Aimed for grades 8-12.

Robert J. Kent, Cornell University, Riverhead, NY.

3.5 Workshop Alexandria

Greening the Curriculum - Natural Resources Curriculum

This session will display the curriculum project, Natural Resource Curriculum: Air, Land and Water. The curriculum is a K-8 interactive ecological approach to natural resources. Two to three modules will be displayed in a unit in which the participants may examine and interact with tools, booklets, and visuals. Interesting for teachers of all ages whether it be a classroom or a scout troop. Science can be more than fun: it can be intriguing

Jane A. Berndt, Ed.D., Montgomery Schools Md, Washington, D.C.

Session 3: Friday, March 3
2:10 - 3:10 PM (continued)

3.6 Workshop Environment Fairfax

Offshore Sampling and Testing Robot (OSATR) Technology Applied to Chesapeake Bay

The NORSTAR Student Research Institute is constructing a remotely controlled robotic water quality sampling watercraft to allow a more uniform and consistent monitoring of the water quality of the Chesapeake Bay and its tributaries. This hands-on workshop will illustrate the process employed by the NORSTAR students with emphasis on how local water quality monitoring can be an integrated learning experience using computers, CD-ROMs, scanners and other high tech devices.

George Skena and **Joy Young**, NORSTAR Student Research Institute, Norfolk, VA.

3.7 Paper Post Secondary Ed. Mt. Vernon

2:10 - 2:30 — Jesse S. Tatum, Rensselaer Polytechnic Institute, Troy, NY. *Science, Technology and Society: Issues in Professionalization and the Future.*

2:30 - 2:50 — Mick Lantis, Purdue University North Central, Westville, IN. *The Next Step Past Computer Literacy.*

2:50 - 3:10 — Ismail Ipek, University of Pittsburgh, Computer & Curriculum Inquiry Center (CCIC), Pittsburgh, PA, *Considerations for Humanism and Technology in Education.*

3.8 Paper Ethics & Values Manassas

2:10 - 2:30 — Melinda L. Kreth, University of Louisville, Louisville, KY. *Challenger. A Reexamination of a Discourse Disaster.*

2:30 - 2:50 — Franz Foltz, Rensselaer Polytechnic Institute, Troy, NY. *Increasing Participation in Global Climate Change Research.*

2:50 - 3:10 — Dr. Thomas Webler, ERD, Wendell, MA. *Promoting Social Learning in Environmental Impact Assessment.*

3.9 Roundtable Am-Life Exhibit McLean

This roundtable will address the controversial issues of the presentation of science in museums. If will specifically focus on the Smithsonian "Science in American Life" exhibit and public reaction.

Ann Mintz (moderator), Orlando Science Center, Orlando, FL, and NASTS President.

3.10 Workshop Post Secondary Education Salon VI

Project AEGIS: Roleplaying an STS Curriculum

Our group will give a demonstration and explanation of an innovative learning technique developed in part under a research grant from the Educational Development Council of Worcester Polytechnic Institute. This project draws upon the traditional characteristics of what are known as "live roleplaying games" (or LRPFs) to provide the students with a different set of learning tools - one that encourages experiential, participative learning rather than the traditional vicarious techniques of lecturing or book learning.

Michael V. Caprio, Jr., Benjamin Bonnett and **N. Harrison Ripps**, WPI, Worcester, MA.

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Session 4: Friday, March 3
3:20 - 4:20 PM

4.1 Roundtable Alexandria

STS, Indigenous Integrative, or Interdisciplinary Knowing in the "Knowledge Society"

There are at least 10 global centers for collecting indigenous knowledge with a major coordinating effort located at the Iowa State University Center. Penn State University has called a multidisciplinary group to examine this form of knowing. Participants will explore the relevance of this reality to STS understanding and education methods for all venues in what Peter Drucker has dubbed the "Knowledge Society."

Robert A. Walker (Moderator), Penn State University, University Park, PA; **Jane Konrad**, Executive Director Pittsburgh Regional Center for Science Teachers; and **Judi Wakhungu**, Penn State, University Park, PA.

4.2 Workshop Jackson

Using Multimedia for Lectures/Demonstrations

In this workshop, participants will learn about a tool that will allow them to illustrate and demonstrate concepts and phenomena taken from various disciplines using digitized slides, full motion video, digital audio, scanned images, compact disc audio, animation sequences, hypertext, and overhead transparencies using a large screen video projector connected to a computer display.

Victor A. Stanionis, Ph.D., Iona College, New Rochelle, NY.

4.3 Paper Post Secondary Education McLean

3:20 - 3:40 — Dr. Doris Z. Fleischer, New Jersey Institute of Technology, Newark, NJ. *Crisis in the Watershed: The Case of the Murdered Messenger.*

3:40 - 4:00 — David Kingsland, Charles McTague, and **Benjamin Kibler**, Worcester Polytechnic Institute, Worcester, MA. *Cognitive and Learning Style Biases in SAT Performance: When Does the SAT Work, and What Can It Tell You?*

4.4 Paper S & T Policy Mt. Vernon

3:20 - 3:40 — Laurel Thomas, American Center for the Study of Distance Education, Penn State University, University Park, PA. *Considerations for New Technology in Distance Education.*

3:40 - 4:00 — Dwayne S. Breger, Lafayette Collete, Easton, PA. *An Economic & Policy Model of a National Transition to Renewable Energy Technologies.*

4:00 - 4:20 — Linda Levine, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA and **Kurt M. Saunders**, Duquesne University, School of Law, Pittsburgh, PA. *The Right of Suppression: Legal and Policy Implications of Technology Non Use.*

4.5 Paper Ethics & Values Manassas

3:20 - 3:50 — R. Eugene Mellican, University Massachusetts Lowell, Philosophy Department, Lowell, MA. *Integrating Ethics into Undergraduate Research: The NSF Research Experiences for Undergraduates Program.*

3:50 - 4:20 — Jere Jones, Ph.D., Raritan Valley Community College, Somerville, NJ. The RVCC *Thesis: The Presence of Ethics and Values in the Technical Curricula.*

4.6 Paper Post Secondary Fairfax

3:20 - 3:40 — Sharon Jones and Indira Nair, Engineering & Public Policy, Carnegie Mellon Univ., Pittsburgh. *Environmental Education as STS Cases.*

3:40 - 4:00 — Cynthia J. Atman, Industrial Engineering Dept., Univ. of Pittsburgh, and **Indira Nair**, Carnegie Mellon Univ., Pittsburgh. *Views and Knowledge of Freshman Engineering and Humanities Majors on STS Issues.*

4:00 - 4:20 — Janice Koch, Curriculum 6 Teaching, Hofstra University, Hempstead, NY. *Integrating Gender Equity Issues in Preservice Science Education.*

4.7 Workshop Ethics and Values Madison

Metaphors of Mathematics in Religion

This workshop will examine the role which mathematics has historically played -- and plays even today -- in religion. Two radical new "mathaphors" will be presented for discussion and exploration: "God and the Definite Integral" and "Cantorian Religion." The session is an innovative mix of ideas and exercises taken from the presenter's teaching and forthcoming book.

Sarah Voss, Unitarian Universalist minister, Director of the Eastern Regional Math and Science Coalition in Omaha, NE.

PLENARY 2:

Friday March 3
4:30-5:30 PM
Location: Salon VI

Introduction: **James J. Murphy**, NASTS, Past President

Speaker: **Paula P. Brownlee**, President, Association of American Colleges & Universities

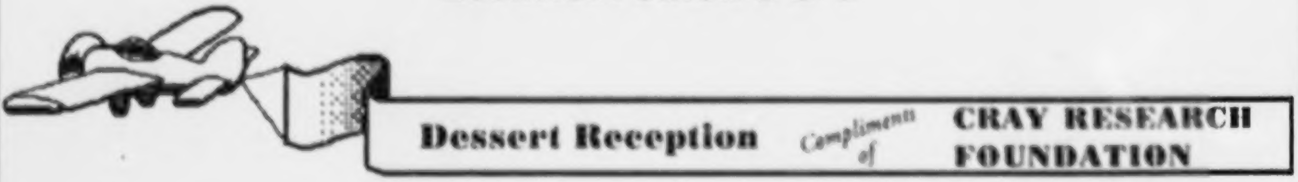
Topic: Journeys of Discovery: The Heart of Learning Science

Board of Directors Meeting

Friday March 3
6:45-8:45PM
Location: Fairfax Boardroom

NASTS Dessert Reception

Friday March 3
8:45-10:00 PM
Location: Salon 1 & 2


Dessert Reception
Compliments of
CRAY RESEARCH FOUNDATION

INSTITUTIONAL MEMBERS
ADVISORY COUNCIL BREAKFAST MEETING
Saturday, March 4
7:00-8:00 AM
Location: Lee Room

Chair: Stephen H. Cutcliffe

- **Babson College:** David Adams
- **Central Missouri State University:** Arthur J. Rosser
- **Colby College:** James Fleming
- **Illinois Math and Science Academy:** Marcelline Barron
- **Iona College:** Victor Stanionis
- **James Madison University:** Jack M. Armistead
- **Kutztown University of Pennsylvania:** John P. Schellenberg

- **Lehigh University:** Stephen H. Cutcliffe
- **Michigan Technological University:** Terry S. Reynolds, Chair
- **Montana College of Mineral Science and Technology:** Pat Munday
- **New Jersey Institute of Technology:** Eric Katz
- **Pennsylvania State University:** Carl Mitcham
- **Raritan Valley Community College:** Jere Jones

- **Rensselaer Polytechnic Institute:** Shirley Gorenstein
- **Southern College of Technology:** Edward A. Vizzini
- **Stanford University:** Robert E. McGinn
- **Trenton State College:** John Karsnitz
- **University of California Santa Barbara:** Fiona M. Goodchild
- **University of Delaware:** John Byrne
- **University of Nevada:** Michael Robinson

- **University of Notre Dame:** Christopher Hamilin
- **University College of Cape Breton:** Kim Bond
- **University of Toronto:** Willem H. Vanderburg
- **Utah State University:** Prent Klag and Donald Fusinger
- **Virginia Tech:** Richard Burian
- **Wayne State University:** Don Cattle
- **Worcester Polytechnic Institute:** John M. Wilkes

EDUCATION ASSEMBLY BREAKFAST
Saturday March 4
Location: Jackson Room

Co-Chairs: **Janice Koch**, Hofstra University
and **John Roeder**, the Calhoun School

Invited NASTS Members to discuss NASTS proposal to form an interdisciplinary "Education Assembly" to cut across all education communities. Assembly would be self-organizing, shape Conference Program, and elect one Board Member. Review Proposal on page 32 of Program Booklet.

INTERNATIONAL STS PROGRAM

INTERNATIONAL STS BREAKFAST
Saturday March 4
7:00-8:00 AM
Location: Jefferson Room

Co-Chairs: **Michael Dyrenfurth**, University of Missouri
and **Robert Yager**, University of Iowa

All International attendees are invited to attend and meet others from the International STS Community. International STS sessions are scheduled Saturday and Sunday. Planning Meeting for organizing International STS organization scheduled for Sunday 2:30-6:30 PM.

PROGRAM

Saturday *(See Sessions 5.4, 6.8, 10.7 and 11.5)*

- **Cheng-Hsia Wang, Ph.d.**, Dept of Chemistry, National Taiwan Normal University, Taipei, Taiwan. *What We Learn from Role Playing in an STS Activity.*
- **Salem Ali Taqui** and **Dr. Mane Al-Sderawi**, National Committee for Technology Transfer, Kuwait Society of Engineering, Al-Safat-3041, Kuwait. *Youth Scientist Programs.*
- **Mammo Muchie**, Middlesex University, London. *An Exploration of the African Contribution to Science to Technology; A New Master's Course in Science and Technology Policy.*
- **Uri Zoller** and **David Ben-Chaim**, Haifa University-Oranim, Dept. of Science Education, Kiryat Tivon, Israel. *High School Students' and Teachers' Outlook Profiles: Are There Gender Differences?* (presented by **Richard Dietrich**, Penn State)
- **Jetty Pohlmann**, Cito, The Netherlands. *New Examination Questions - Biology and Society.*
- **Cub Kahn**, Dutchess Community College/SUNY, Poughkeepsie, NY. *Development of an Undergraduate Environmental Curriculum in Bangladesh.*
- **Lars Fuglsang**, Roskilde University, Roskilde, Denmark. *Reflections on International STS: STS as an Issue-Area.*
- **Khalijah Mohd-Salleh**, Universiti Kebangsaan Malaysia, Bangi, Malaysia. *Promoting Public Interest in STS in Malaysia.*

Sunday *(See Session 13.1)*

Technology, Development and Environment: An International Comparison

Jahiel: *China's Economic Reforms and the Rationalization of Environmental Dispute Resolution;* **Hsu** and **Byrne:** *Community or Commodity — Reconsidering the Environment Movement in Taiwan;* **Byrne, Hoffman** and **Martinez:** *Commodification and the Collapse of Community: Nuclear Power and the Native American Communities of the American West.*

Cecilia Martinez (moderator), **Abigail Jahiel**, **Shih-Jung Hsu** and **John Byrne**, all of the Center for Energy and Environmental Policy, University of Delaware, Newark, DE.

Sunday International STS Planning Meeting: 2:30-6:30, Alexandria Room

NORTH AMERICAN COALITION ON RELIGION AND ECOLOGY (NACRE) PROGRAM

Saturday March 4

10:20-3:50

Sessions 6.1, 7.1, 8.1, 9.1

Location: Salon VI

Special Session 1.

Ethics and the Global Challenge: Cairo, Copenhagen and Beyond

Rev. Doug Hunt, Churches Center for Sustainable Community

Special Session 2.

Educational and Pastoral Dimensions for Local Action

Don Conroy, President, The North American Coalition on Religion and Ecology (NACRE)

Special Session 3.

Religion and Ecology in a New Dialogue

Ian Barbour, Author, *Ethics in an Age of Technology*

Special Session 4.

Technology & the Triune Brain: From Consumerism to Wellness Dynamics

Jeremy Wright and **Deva Beck**, The Wellness Foundation

Sponsored by North American Coalition on Religion and Ecology (NACRE)

Session 5: Saturday, March 4
8:00 - 9:00 AM

5.1 Workshop K-12 Education Jackson

International System of Units in K-12 Education Computer Aided Instruction

A good understanding and proficiency in using the International System of Units (SI) is essential in today's global society. Textbooks in mathematics and science on the K-12 level do not provide an in-depth study of the International System of Units and its "real world" applications. K-12 students are entering our Society and post-secondary institutions with an inadequate knowledge or in some cases a total unawareness of the international System of Units and its implications and applications. Author of this presentation has developed a computer software to be used as an instructional supplement in teaching the International System of Units. The software to be presented is fully interactive and starts by defining the seven basic units of measurement.

Wieslaw Grebski, The Pennsylvania State University, Hazelton, PA .

5.2 Workshop 6-12 Education Salon VI

A High School Science Research Course

A science research course, in which students recruit top research scientists from anywhere in the United States as mentors, has yielded extraordinary results at a non-magnet, nontechnical low enrollment high school. These students, who are chosen on the basis of interest and of academic achievement, acquire self confidence and problem solving skills that will serve them throughout their lives. This workshop will describe the course in detail, and discuss methods for its transfer to other schools.

Dr. Robert Pavlica, Byram Hills H.S., Armonk, NY.

5.3 Workshop Post-Secondary Education Madison

Collaborative Learning in the STS Classroom

This workshop demonstrates a format that was developed to introduce collaborative learning into a large (>100) general education, environmental science course. Students worked in collaborative groups of six, with each student in the group evaluating the course material from a particular perspective. These perspectives were: Current Human Population, Future Human Population, Other Species, Non-Living Environment, Socio-Political Concerns and Economic Concerns.

Anthony J. Becker, Jr., The National Faculty, New Orleans, LA.

5.4 Paper International STS Jefferson

8:00 - 8:20 — **Cheng-Hsia Wang, Ph.d.**, Dept of Chemistry, National Taiwan Normal University, Taipei, Taiwan. *What We Learn from Role Playing in an STS Activity.*

8:20 - 8:40 — **Salem Ali Taqui and Dr. Mane Al-Sderawi**, National Committee for Technology Transfer, Kuwait Society of Engineering, Al-Safat-3041, Kuwait. *Youth Scientist Programs.*

8:40 - 9:00 — **Mammo Muchie**, Middlesex University, London. *An Exploration of the African Contribution to Science to Technology.*

5.5 Paper K-12 Education Manassas

8:00-8:30 — **Glenda R. Haynie**, Mathematics Department and **W. James Haynie**, Technology Education Program, North Carolina State University, Raleigh, NC. *Mathematics: An Important Interface Language for STS.*

8:30-9:00 — **Samuel Masih, Ph.D.**, Albany State College, Albany, GA. *Multimedia Interactive Course in Trigonometry.*

Session 5: Saturday, March 4
8:00 - 9:00 AM (continued)

5.6 Paper K-12 Education Fairfax

8:00-8:20 — **Paul Jablon**, Brooklyn College, Brooklyn, NY and **Andrea Egitto**, PS33, Queens Village, NY. *Summer STS Camp for Teachers and Students.*

8:20-8:40 — **Bernice Hauser**, Horace Mann School, Riverdale, NY, *Open Park/Vacant Lot - Catalyst for Change.*

8:40-9:00 — **Catherine Stephenson**, Westmont-Hilltop School District, Johnstown, PA, *Literature Based Math/Science Activities.*

5.7 Paper S & T Policy Mt. Vernon

8:00-8:20 — **John A. Waring**, Arlington, VA, *The Social Design of Science - In Concert with the Cultural Arts.*

8:20-8:40 — **Mitchell R. Malachowski** and **Dennis Rohatyn**, University of San Diego, San Diego, CA. *Just the Facts, Ma'am: The Soft Core of Hard Science.*

8:40-9:00 — **Philip J. Frankenfeld, Ph.D.**, Milwaukee, WI. *Boss Design: Postmodern Architecture and Design That Jars Us Into Technological Citizenship.*

5.8 Paper Research Alexandria

STS Research at Virginia Tech
Part 1

A two-hour symposium in which three Ph.D. students from the Graduate Program in STS at Virginia Tech will present papers based on the research they are doing for their doctoral dissertations. This work exemplifies both the styles and scope of research found in our program. *(continued)*

5.8 Paper Research Alexandria
(continued)

Joseph C. Pitt (moderator), Virginia Tech, Blacksburg, VA

Ahmed Bouzid, STS Grad Program, Virginia Tech, *Sayyid Qutb: Natural Science in the Service of Islamic Activism.*

Michael Seltzer, STS Grad Program, Virginia Tech, *Creationism and Evolution, Towards a Postmodernist Historiography of Science.*

Anne Fitzpatrick, STS Grad Program, Virginia Tech and Los Alamos National Laboratory, *The Philosophy of Science in Nuclear Policy in the 1950's.*

Continues in Session 6.9

5.9 Paper Philosophy McLean

8:00 - 8:20 — **Robinson Lilienthal**, New Jersey Inst. of Technology, Newark. *Nietzcsche's Contribution Towards an Environmental Philosophy.*

8:20 - 8:40 — **Bert Kimmelman**, New Jersey Inst. of Technology. *Wordlessness, Virtual Reality, and Limits of Technology.*

Organized by **Eric Katz**, New Jersey Inst. of Technology.

PLENARY 3:
Saturday March 4
9:10-10:10 AM
Location: Salon VI

Introduction: Don Conroy, President, The North American Coalition on Religion and Ecology

Speaker: **Senator Gaylord Nelson**, Founder of Earth Day, Counselor for the Wilderness Society

Topic: **Sustainability and Earth Stewardship: Choices for the 21st Century**

Session 6: Saturday, March 4
10:20 - 11:20 AM

6.1 Program on Earth Stewardship Salon VI

Special Session 1.
Ethics and the Global Challenge:
Cairo, Copenhagen and Beyond

Rev. Doug Hunt, Churches Center for Sustainable Community

Sponsored by North American Coalition on Religion and Ecology (NACRE)

6.2 Panel Ellul Symposium Lee

The Contribution of Jacques Ellul to STS
Part 1

A two hour panel discussion. Jacques Ellul was one of the great STS thinkers of this century; and it is fitting that his passing be marked by a reflection on his enormous contribution to the field.

Willem Vanderburg (moderator), Centre for Technology and Social Development, University of Toronto, Toronto, Ontario; **Langdon Winner, Dick Stivers, Andrew Kimbrell and Henry Johnson.**

6.3 Roundtable Education McLean

STS Integrated Teaching at the High School Level

Presenters will describe the Carl Hayden High School freshman core program, where teachers of four content areas (biology, English, history and reading) work together in a cooperative effort to integrate the curriculum using the STS approach. The goals will be discussed as well as a rationale for using the STS approach. A student attitude assessment and video of student interviews evaluating the merits of the program will also be included. participants will be provided with copies of the units, the authentic assessment model and rubrics used during the year.

Deanne Falls, Susan Ford and **Lynn Palacios**, Carl Hayden Community High School-Phoenix Union High School District, Phoenix, AZ.

6.4 Panel Jackson

Technology in Context: Three Historical Case Studies

Historians of technology generally view the societal context in which the technical artifact resides as essential to a full understanding. Three recently concluded case studies will illustrate this central theme in STS studies. **Gelberg**: *How Sports Technology Policy Shapes Our Games: The Case of the Plastic Football Helmet;* **Eldridge**: *Poisoned Painters: Organized Painters and the Debate Over Occupational Lead Poisoning, 1900-1930;* **Schramm**: *Black Diamonds No More: A Technological History of the Dieselization of the Lehigh Valley Railroad.*

Stephen Cutcliffe (moderator), Lehigh Univ., **J. Nadine Gelberg**, STS Program, Penn State; **Christopher Eldridge**, History Dept., Lehigh Univ., Bethlehem, PA; and **Jeffrey W. Schramm**, History Dept. Lehigh Univ., Bethlehem, PA.

6.6 Workshop Pre-College Education Madison

Integrating Design & Technology
Into the Elementary Curriculum

This presentation will provide each participant with an overview and hands-on experience of the National TsaTechnoKids program. TsaTechnoKids utilizes the teaching of design and technology approach toward teaching children technology as an integrated component of the elementary classroom (K-6).

Steven Barbato, Applied Educational Systems, Inc., Lancaster, PA and **Sandy Honour**, National Technology Student Association, Reston, VA.

Session 6: Saturday, March 4
10:20 - 11:20 AM (continued)

6.7 Paper 6-12 Education Manassas

10:20 - 10:50 — Dr. David M. Burghardt Hofstra University, Hempstead, NY; **M. Michael Hacker**, NYS Education Dept., Albany, NY; and **Ira Schwartz**, Hofstra University, Hempstead, NY. *NYSTEN: A New York State MST Initiative.*

10:50 - 11:20 — John G. Wells and **Daniel V. Tryon**, both of West Virginia University, Morgantown, WV. *Biotechnology: An Instructional Approach for Technology Educators.*

6.8 Paper International STS Mt. Vernon

10:20 - 10:40 — Uri Zoller and **David Ben-Chaim**, Haifa University-Oranim, Dept. of Science Education, Kiryat Tivon, Israel. *High School Students' and Teachers' Outlook Profiles: Are There Gender Differences?*(presented by **Richard Dietrich**, STS Penn State)

6.8 Paper International STS Jefferson

10:40 - 11:00 — Jetty Pohlmann, Cito, The Netherlands. *New Examination Questions - Biology and Society.*

11:00 - 11:20 — Cub Kahn, Dutchess Community College/SUNY, Poughkeepsie, NY. *Development of an Undergraduate Environmental Curriculum in Bangladesh.*

6.9 Research Alexandria

STS Research at Virginia Tech
Part 2 *(cont. from 5.8)*

A two-hour symposium in which three Ph.D. Students from the Graduate Program in STS at Virginia Tech will present papers based on the research they are doing for their doctoral dissertations. *See Session 5.8* for description.

Session 7: Saturday, March 4
11:30 - 12:30 PM

7.1 Talk Program on Earth Stewardship Salon VI

Special Session 2.
Educational and Pastoral Dimensions for Local Action

Don Conroy, President, The North American Coalition on Religion and Ecology (NACRE)

7.2 Panel Ellul Symposium Lee

The Contribution of Jacques Ellul to STS
Part 1 (continued)

A two hour panel discussion. Jacques Ellul was one of the great STS thinkers of this century; and it's fitting that his passing be marked by a reflection on his enormous contribution to the field.

Willem Vanderburg (moderator), Centre for Technology and Social Development, University of Toronto, Toronto, Ontario; **Langdon Winner, Dick Stivers, Andrew Kimbrell** and **Henry Johnson.**

7.3 Panel International STS Mt. Vernon

Effects of Moral Dilemma Episodes on Moral Values

The main purpose of this study was to investigate the effects of using the moral dilemma episodes in inculcating moral values of Form One students (Grade 7) in science lessons. The study also includes the effects of the moral dilemma episodes on students' academic performance. Comparisons of moral values of boys and girls, and of students staying in housing estates and students staying in squatter areas were also made.

Sulaiman Ngah Razali, University of Malaya, Kuala Lumpur, Malaysia.

Session 7: Saturday, March 4
11:30 - 12:30 PM (continued)

7.4 Roundtable Pre-College Manassas

Middle School Students' Conceptions of Global Warming and Views About the Nature of Science Following STS Instruction

During the summers of 1992 and 1993, middle and high school science teachers from rural West Virginia and Pennsylvania participated in a Leadership Institute in STS Education funded by the National Science Foundation. The Institute focused on the science, technologies, politics and economics related to global warming. Using the goal structure developed by Rubba and Wiesenmayer (1985, 1989), the teachers developed and implemented STS units.

This session will report on middle school students' conceptions related to global warming and views about the nature of science following STS instruction.

Thomas Ditty, Graduate Student, West Virginia University, Morgantown, WV. *An Overview of the STS Global Warming Curriculum and the Student Interview Process.*

Randall L. Wiesenmayer, Associate Professor of Science Education. *Students' Conception About Global Warming.*

Peter A. Rubba, Professor of Science Education, Penn State. *Students' Misconceptions About Global Warming.*

7.5 Workshop 6-12 Education Jackson

Science and Technological Education Via Computer Networking in the Vocational Technical Setting

Workshop will review goals and objectives, outline a network plan and demonstrate applications with a free standing multi-media station. A questionnaire will be used to guide participants in assessing their current technological environment. Advice and suggestions on how to develop a networking plan will be offered.

Eric J. Weiland, James G. Bennett and **Lee J. Lesisko**, Lehigh County Vocational Technical School, Schnecksville, PA.

7.6 Paper Ethics & Values Alexandria

11:30 - 12:00 — Jesse S. Tatum, Rensselaer Polytechnic Institute, Troy, NY. *Computer Ethics: Missing the Forest for the Trees?*

12:00 - 12:30 — Jeffrey H. Collins, Professor, Oglethorpe University, Marietta, GA. *Nascent Communication Technologies in the Urban World: An Anthropological Perspective.*

7.7 Paper 6-12 Education Fairfax

11:30 - 12:00 — William T. Peruzzi, New York STS Education Project, Albany, NY. *A Middle-level STS Module on Wildlife.*

12:00 - 12:30 — S. Bruce Kohrn, Rensselaer Polytechnic Insitute, Amherst, NY. *Interactive Multimedia for a NYSTEP Module.*

7.8 Paper K-12 Education McLean

11:30 - 12:00 — Karen F. Zuga, Ohio State University, Columbus, OH. *Theoretical Progress in Technology Education.*

12:00 - 12:30 — James R. Gray, Northern Kentucky University, Highland Heights, KY. *A Seminar Approach to the Study of Technology.*

LUNCH MEETING ROUNDTABLE
12:30-1:30
Location: Alexandria
(bring your own lunch)

"Women Networking in Science & Technology"

Janice Koch(moderator), Hofstra University

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Session 8: Saturday, March 4
1:40 - 2:40 PM

8.1 Program on Earth Stewardship Salon VI

Special Session 3.
Religion and Ecology in a New Dialogue

Ian Barbour, Author, *Ethics in an Age of Technology*

Sponsored by North American Coalition on Religion and Ecology (NACRE)

8.2 Panel Ellul Symposium Lee

Betrayal By Technology
Part 2 (2 hours)

Clips from documentary film on Jacques Ellul, entitled, "Betrayal by Technology," followed by panel discussion by symposium presenters in Part 1. Open discussion: "STS. . . Where Do We Go From Here?"

Willem Vanderburg (moderator), Centre for Technology and Social Development, University of Toronto, Toronto, Ontario; Panelists: **Henry Johnson, Andrew Kimbrell, Rustum Roy, Dick Stivers** and **Langdon Winner**.

8.3 Special Symposium Jefferson

Special 2 hour Symposium on the Built Environment
Part 1.

Robert Mark, Princeton University. *Building of Medieval Cathedrals. Structural Mechanics: How Much Did They Know?*

Paul Byard, former President of NY Architectural League. *School Buildings. Connection Between Schools and Cities.*

Paul Levy, Former Director, Mass. Water Research Authority. *The New Tunnel Beneath Boston Harbor.*

Leon Trilling (moderator), Program in STS, MIT.

8.4 Panel Jackson

Preventing the Virtual Ghetto: Electronic Equity through Community Telecomputers

This session will provide participants with information they can use to help their local communities to address the issue of electronic equity. They will describe the development of low-cost community telecommuting cooperatives. The goal: prevent virtual ghettos, while getting all members of a community to work together to improve both their virtual and real lives.

Sponsored by the LINCT Coalition, a group of socially concerned not-for-profit organizations working with communities interested in helping the technologically disenfranchised.

Frank Withrow (moderator), Director, Education Technology, Council of Chief School Officers; **Ken Komoski**, EPIE Institute, Hampton Bays, New York; **Curtiss Priest**, Center for Technology Information and Society, Melrose, MA; and **Edgar Cahn**, TIME Dollars Network, Washington, DC.

Session 9: Saturday, March 4
2:50 - 3:50 PM

9.1 Program on Earth Stewardship Salon VI

Special Session 4.
Technology & the Triune Brain: From Consumerism to Wellness Dynamics

Jeremy Wright and **Deva Beck**, The Wellness Foundation

Sponsored by North American Coalition on Religion and Ecology (NACRE)

9.2 Panel Ellul Symposium Lee

Betrayal By Technology
Part 2 (continued)

see 8.2 for details

9.3 Special Symposium Jefferson

Special 2 hour Symposium on the Built Environment Part 2.

Robert Mark, Princeton University. *Building of Medieval Cathedrals. Structural Mechanics: How Much Did They Know?*

Paul Byard, former President of NY Architectural League. *School Buildings. Connection Between Schools and Cities.*

Paul Levy, Former Director, Mass. Water Research Authority. *The New Tunnel Beneath Boston Harbor.*

Leon Trilling (moderator), Program in STS, MIT.

9.4 Workshop Pre-College Education Salon VI

Young Inventioneers of America

Young Inventioneers of America is a program for children and students. The objective of the program is to make available to America's young the opportunity to invest and mold their own future and contribute at an early age to this future and to the future of America.

The program will offer these benefits to the young inventor: (1) a regional invention convention; (2) buyers who would come and grade these inventions *(cont.)*;

9.4 Workshop Pre-College Education Salon VI

(continued)

(3) winning prototypes will be chosen to be designed, manufactured and marketed; (4) a royalty will be paid to the student or parents of the student per unit sold.

Michael E. Bader, President, Northwest Brainchild Foundation, Protonaut, Inc., Bellevue, WA.

9.5 Workshop Post Secondary Education Madison

Teaching Information Self-sufficiency in the Academic Disciplines: A Three-Tiered Approach

At the University of Denver, the goal of the reference faculty is to foster technological self-sufficiency in information retrieval to support ongoing teaching and research efforts at the university, and to ensure that the next generation of professionals will understand their options in acknowledge-based society. Techniques for teaching information literacy will be demonstrated.

Deborah S. Grealey and **Lorraine Evans**, University of Denver, Denver, CO.

9.6 Workshop Other Alexandria

Scientific Work Experience Programs for Teachers

Scientific Work Experience Programs for Teachers (SWEPT) is a project funded by the National Science Foundation and the National Aeronautics and Space Administration to disseminate information about scientific work experience programs in order to lead to their replication across the United States. The Triangle Coalition for Science and Technology Education in conjunction with its program partners, including representatives from operating SWEPTs, is disseminating planning materials and offering technical assistance to help establish these programs.

Matt Freund, Triangle Coaltion, College Park, MD and **Marie Earl**, IISME, Santa Clara, CA

9.7 Paper Mt. Vernon

2:50 - 3:50 – **Richard Satava**, Advanced Research Projects Agency, Arlington, VA. *Robotics, Telepresence and Virtual Reality in Medicine: Leveraging Science and Myth to Fulfill the "Dream."*

Session 10: Saturday, March 4
4:00 - 5:00 PM

10.1 Roundtable STS Policy Fairfax

Shaping the Future: STS and the Designing University

STS needs internal coherence and a balanced agenda. STS needs to keep pace not only with changes in technology and science, but with changing political, economic and cultural forces. Doing so appears to be a mandate of STS within the university and it is assuming ever larger salience as a need of contemporary society. To control the future we must take design as our most important activity. Design is where technological resources meets human needs. Our students must know how to design our futures. We must know how to design the designers. Design can integrate STS by being the application of the critical notion of social constructivism. Taught in teams it will force the issue of interdisciplinarity. Design is a wonderful paradigm for studying history and politics, but it is also excellent for understanding the social context of science.

Richard Devon, Penn State University, University Park, PA

10.2 Panel Jackson

Congress and Education Reform: An Update

The 103rd Congress passed the most comprehensive set of Education proposals in a generation. How do these major pieces of legislation work together to support reform? How is their effectiveness likely to be affected by the advent of a Republican led 104th Congress: What is the truth about cuts in education funding? If you are interested in these and other issues rising out of the changes on Capitol Hill on science and mathematics, technology and school-to-work, this session is for you.

Gary G. Allen, Triangle Coalition, College Park, MD.

10.3 Panel Post Secondary Ed. Jefferson

Engineering Education and Engineering Practice: Improving the Fit

This panel will be devoted to illuminating various kinds of "disconnects" or "gaps" between the nature and requirements of contemporary engineering practice and the content of contemporary engineering education in the U.S.

Robert E. McGinn (moderator), STS Program, School of Engineering, Stanford University, Stanford, CA; **Louis L. Bucciarelli**, MIT School of Engineering, Cambridge, MA; **Sarah Kuhn**, Univ. of Mass (Lowell), College of Management; **Taft H. Broome**, Howard Univ. School of Civil Engineering, Washington, DC.

10.4 Paper S & T Policy McLean

4:00 - 4:30 — Susan A. Hagedorn, Virginia Tech, Blacksburg, VA. *Public Perception Issues in Agricultural and Environmental Biotechnology.*

4:30 - 5:00 — W.A. Sedelow and **S.Y. Sedelow**, University of Arkansas/Little Rock, Heber Springs, AR. *Leibniz Redivivus: High Tech with Deep Science and the Resolution of Public Differences.*

10.5 Panel 6-12 Education Madison

The WPI Student Initiative: Toward a Complete Sixth Grade S-STS Curriculum

Part 1. *The Format of an S-STS Unit Matters: Evidence from the WPI Sixth Grade Project.* A major focus at WPI has been to establish a standard for all future units, such as: how the unit should be organized, where and when the social issues would be presented, and how each lesson should be organized.

Part 2. *Drawing on Local History to Motivate Science Study: the Quabbin Reservoir Controversy.* Describes how the new curriculum uses local Massachusetts history to teach an S-STS unit.

Maria Salvati, John Wilkes, Jeffrey Modderno, and **Robert Tonning**, Worcester Polytechnic Institute, Worcester, MA:
Discussant: **Robert E. Yager**, University of Iowa.

Session 10: Saturday, March 4
4:00 - 5:00 PM (continued)

10.6 Paper 6-12 Education Manassas

4:00 - 4:30 — Erma Anderson, Teacher Center/NSTA, Arlington, VA. *National Science Education Standard & Implications for Science Education.*

4:30 - 5:00 — Michael Hacker, New York State Education Department, Albany, NY. *A Statewide K-12 Curriculum Framework for Math, Science and Technology: An Emerging Paradigm in New York.*

10.7 Paper International STS Mt. Vernon

4:40 - 5:00 — Mammo Muchie, Middlesex Univ., London. *A New Master's Course in Science and Technology Policy.*

10.8 Paper S & T Policy Lee

4:00 - 4:20 — David McBride, Penn State University, University Park, PA. *National Minorities and Biomedical Modernization: A One-Century Over View of Blacks in United States Medicine.*

4:20 - 4:40 — Robert A. Bohrer, California Western School of Law, San Diego, CA. *Risk Assessment for Gene Therapy.*

4:40 - 5:00 — Deborah Blizzard, Department of Science and Technology Studies, Rensselaer Polytechnic Institute, Troy, NY. *Women and Genes: Finding the Right Fit.*

10.9 Paper Ethics & Values Alexandria

Technology and Politics

Stephen Cutcliffe (moderator), Lehigh University

4:00 - 4:20 — Gregory C. Kunkle, Dept. of History, Lehigh University, Bethlehem, PA. *Democratizing Technology?: Congressional Control and Public Participation in the History of the Office of Technology Assessment.*

4:20 - 4:40 — Peter M. Bearse, Dept. of Economics, University of Virginia, Charlottesville, VA. *Computer Techniques and Crime Policy: Quantifying and Analyzing Poverty, Crime, and Deterrence As It Relates to the Impact of Crime Policy.*

4:40 - 5:00 — Albert H. Wurth, Jr., Dept. of Government, Lehigh University, Bethlehem, PA. *Decision Points and Public Review: Creating Conditions for Public Participation in Technological Decisions.*

Session 11: Saturday, March 4
5:10 - 6:10 PM

11.1 Press Conference Salon VI

Values-Driven Environmental Policies

Joint Press Conference NACRE & NASTS

Amory Lovins - Director, Rocky Mountain Institute

Jan Hartke - Chair, North American Alliance for Religion & Ecology

Professor Ian Barbour - Gifford Lecturer, Edinburg, 1993

11.2 Panel Research Jefferson

STS As Public Philosophy

Durbin: "STS as Philosophical Social Work;" McGinn: "STS on Pluralist Practical Philosophy;" Waks: "Public Philosophy & STS Education."

Carl Mitcham (Chair), Colorado School of Mines/Penn State University, University Park, PA; **Paul T. Durbin**, Univ. of Delaware; **Robert McGinn**, Stanford Univ., Stanford, CA; and **Leonard Waks**, Temple & Maryland Center for Philosophy & Public Policy

Session 11: Saturday, March 4
5:10 - 6:10 PM (continued)

11.3 Workshop 6-12 Education Madison

Teaching About the History and Nature of Science and Technology

A national initiative to infuse science reform and interdisciplinary technique in the teaching of scientific and technological literacy, this project is intended as a curriculum strand in science and social studies classrooms and interdisciplinary topics for middle and senior high students.

Includes active participation in sample lessons for both middle and high school levels, copies of the teacher guide and course outlines for each participant, evaluative criteria, materials and resources lists, recommendations for infusion and instructional strategies.

Janice Lane, St. Louis Park High School, St. Louis Park, MN; **Marilyn R. McClain**, Palmetto Middle School, Miami, FL; and **Sara Thompson**, University of Colorado, Social Science Education Consortium, Boulder, CO.

11.4 Paper Post-Secondary Ed Manassas

5:10 - 5:30 — **Art Hobson**, Professor of Physics, Univ. Arkansas, Fayetteville, AR. *Physics Concepts and Connections: A Text for Non-Scientists.* Based on Prof. Hobson's new textbook, whose central premise is that non-scientists deserve a true liberal-arts physics course.

11.5 Paper International STS Mt. Vernon

5:10 - 5:40 — **Lars Fuglsang**, Roskilde University, Roskilde, Denmark. *Reflections on International STS: STS as an Issue-Area.*

5:40 - 6:10 — **Khalijah Mohd-Salleh**, Universiti Kebangsaan Malaysia, Bangi, Malaysia. *Promoting Public Interest in STS in Malaysia.*

11.6 Roundtable K-12 Education Lee

Living History: STS and Roleplaying at the Sixth Grade

Due to the interdisciplinary nature of an STS curriculum, many of the units which have been evaluated in the public schools have been taught with cooperation between the science and social studies teachers. A new unit was created to incorporate the world history theme called "The Tangled Web of Bronze." This concept is a distinct break from traditional STS units which develop out of current events. The unit uses many innovative techniques, extensive role-playing and hands-on experiments.

Thomas Russell, Beverly Koch and **Alison Possas**, Worcester Polytechnic Institute, Worcester, MA.

11.7 Workshop Pre-College Education Fairfax

Building A Solar Powered Vehicle Using Performance Based Outcomes With Interdisciplinary Studies

Presentation will consist of demonstrating how this project used teachers and students across discipline areas. The presentation will include the concept of the idea, the preparation and planning of this project, funding, student integration across subject areas, student assessment, developing student portfolios and the final evaluation of the project as a whole.

Jeff Jones and **Bill Brayshaw**, Apollo-Ridge High School, Spring Church, PA.

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TENTH ANNIVERSARY DINNER CELEBRATION

Saturday March 4
6:30-9:30 PM
Location: Salon 1

Dinner: 6:30 PM

Award: Honorary Memberships

Program: 7:30 PM, "Present at the Creation"

Guests: Jane Abbott, Paula Brownlee, George Bugliarello, Carolyn Graham, John Guffey, Jon Harkness, Paul DeHart Hurd, Irma Jarcho, Frank Long, Rustum Roy, James Rutherford, John Truxal, Robert Yager, Dorothy Zinberg

PLENARY 4:

Robert Rodale Lecturer for 1995

Saturday March 4
8:30-9:30 PM
Location: Salon 1

Introduction: Rustum Roy, NASTS Corporation Chair

Award Presentation John Guffey, Exec. V.P. Calvert Social Investment Fund, Vice Chairman, Calvert Group Funds

Speaker: Amory Lovins, Director, Rocky Mountain Institute

"Negawatts and Hypercars: Saving Energy and the Earth for Fun and Profit"

NASTS MEMBERS MEETING

Saturday, March 4
9:40-10:40 PM
Location: Salon VI

Session 12: Sunday, March 5
9:50 - 10:50 AM

12.1 Panel **International STS** **Mt. Vernon**

Technology, Development and Environment: An International Comparison

Jahiel: *China's Economic Reformas and the Rationalization of Environmental Dispute Resolution;* **Hsu** and **Byrne:** *Community or Commodity — Reconsidering the Environment Movement in Taiwan;* **Byrne, Hoffman** and **Martinez:** *Commodification and the Collapse of Community : Nuclear Power and the Native American Communities of the American West.*

Cecilia Martinez (moderator), **Abigail Jahiel, Shih-Jung Hsu** and **John Byrne**, all of the Center for Energy and Environmental Policy, University of Delaware, Newark, DE.

12.2 Workshop **Other** **Jackson**

I Tune Cities

The audience will discover how and why the "mind of the city" operates simple mechanisms. When asked several years ago about my profession, I responded "I tune cities." As an urban planner, the more challenging element has been the concept of being disabled. The essence of chaos, order through fluctuations, and the concept of a city's neural network will be reflected in a simple, geographical social equity and future needs of the city and all citizenry.

William J. Wells, Louisville, KY.

12.3 Panel **Environment** **Lee**

The Challenger Disaster and the NASA Mindset... on "Accidents" Waiting to Happen

This will be the debut of a new videotape designed to raise issues about the Interaction Society and Technology featuring National Aeronautics Space Agency and the Space Shuttle Challenger. The panel intends to examine some of the major influences on NASA such as political setting, media, and mindset. We plan to show how NASA's organizational decisions are affected by these influences and display NASA's established pattern of behavior. We further intend to relate NASA's organization to that of another space program, the European Space Agency.

Christian Kuawa, Jose Orbegazo, Donald Chubin and **James Powers**, Worcester Polytechnic Institute, Worcester, MA.

12.4 Paper **S & T Policy** **Alexandria**

9:50 - 10:20 — Bo Shen, Center for Energy and Environmental Policy, University of Delaware, Newark DE. *An Alternative Energy System for China's Economic Sustainability.*

10:20 - 10:50 — Rebecca J. Wykoff, Center for Energy and Environmental Policy, University of Delaware, Newark, DE. *The Role of Energy in the Postindustrial Paradigm: A critique of the Postindustrial Vision.*

12.5 Paper **Environment** **McLean**

9:50 - 10:20 — Cheryl Coolidge and **Denise Turcotte**, Notre Dame College, Manchester, NH. *Exploring Earth and Life Through Time.*

10:20 - 10:50 — Stephen Petrina, North Carolina State University, Raleigh, NC. *Intersections of Psychology, technology and Education.*

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Session 12: Sunday, March 5
9:50- 10:50 AM

12.6 Workshop Jefferson

Addressing the Social and Ethical Issues in Science and Technology: The Global Issues Guidebook

Participants will learn about Student Pugwash USA's student-authored curriculum resource, the Global Issues Guidebook, and how it can be used to inspire challenging, interactive discussions on important global issues. The Guidebook highlights the interdisciplinary nature of issues of science, technology and society relating to the thematic areas. The Guidebook is presented in a format which can be used in classroom settings or in extracurricular student group discussions.

Nicola Short and **Laura Baraff**, Student Pugwash USA, Washington, DC.

12.7 Workshop Madison

STS Interaction: A Core Course For Science Teacher Preparation

Information is presented about an STS course developed at USF to prepare future teachers of science and other subjects to use STS as an organizing context for instruction.

Barbara S. Spector and **Thomas LaPorta**, University of S. Florida, Tampa, FL.

12.8 Paper **University Education** **Manassas**

8:40 - 9:10 — **Tom O'Brien**, Dept. of Biology, Nassau Community College, Garden City, NY. *Innovative Multidisciplinary Courses Require Innovative Multidisciplinary Exams.*

9:10 - 9:40 **Dennis R. Herschbach**, University of Maryland, College Park, MD. *Technology as Process: Implications for Instruction.*

PLENARY 5:
Incogniti Trust Lecturer for 1995
Sunday March 5
11:00-12:00 AM
Location: Salon VI

Introduction:	Leon Trilling, Program in STS, MIT
Award Presentation:	Rustum Roy, NASTS Corporation Chair
Speaker:	James Rouse, Founder of Columbia, MD; President of Enterprise Foundation, National Authority on City, Neighborhood Building
Topic:	Social Ecology of a City

CONFERENCE CLOSING

Ann Mintz, NASTS President
Jane Konrad, NASTS President-Elect

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STS-11 PLANNING MEETING

Sunday March 5
12:30-3:30 PM
Location: Lee Room

Open to interested NASTS Members

INTERNATIONAL STS PLANNING MEETING

Sunday March 5
2:30-6:30 PM
Location: Alexandria Room

Chair: Rustum Roy, Corporation Chair, NASTS

Agenda

1. Reports by sister organizations, WOCATE, ICASE, IOSTE
2. Discussion of structure of new International STS organization: All International delegates.
3. Proposal by *Hideto Nakajima,* RCAST, Tokyo University, for the First International STS Conference in 1997
4. Steps to set up organization
5. Formation of a Planning Committee

DRAFT PROPOSAL TO STREAMLINE NASTS

February 14, 1995

1. NASTS will retain its key role as a viable national focus of diverse interest groups built around STS.

2. The key change proposed is to organize NASTS' functions around a federation of five "Assemblies". These "Assemblies" represent the combination of communities in NASTS which have shaken out over time and shown the greatest longevity and strength. These are: (1) ***Education Assembly***, integrating k-12, college, university, informal; (2) ***History, Sociology & Philosophy of Science***; (3) ***Applied Science, Technology and Engineering***; (4) ***Public Policy***; and (5) ***Ethics, Values & Religion***. We can also imagine an Industry Liaison group. Devolve as much activity to these Assemblies as possible. NASTS headquaraters would remain at PSU for accounting, mail collection, and conference organizing purposes for the near future.

3. These Assemblies would have chairs, each with some institutional backup. We have secured agreement from the individuals in bold italics to act as co-chairs for this first interim year. We have folded in current board members and others, but these are just suggestions requiring their agreement. The proposed assemblies are: (1) Education Assembly (***Roeder, Koch***, Mintz, Nelson, Robinson, Zuga); (2) History, Sociology & Philosophy of Science Assembly (***Durbin***, ***Wilkes***, McGinn); (3) Applied Science, Technology and Engineering Assembly (***Roy***, Liao, Broome); (4) Public Policy (***Dick Sclove*** [Hampshire College], Daryl Chubin [NSF], Wil Lepkowski [C&EN], Gary Chapman; and (5) Ethics, Values and Religion Assembly (Ian Barbour). Three and four may be combined for now.

4. Arrange for the new Assemblies to meet during STS-10. After the conference, the Assembly chairs would meet together (with interested members) Sunday afternoon to plan next year's meeting. They would also be on hand for the Saturday evening Members Meeting where this proposal would be discussed in general. In addition, each Assembly could, on its own, arrange any activity or a meeting anywhere -- for example, put on STS sessions at the venue of NSTA, SHOT, ITEA, ASEE, or other associations. In this regard, the Assemblies would operate autonomously as "ambassadors" of STS, and bring to the national STS meeting reports of activity in other related areas. We have long talked of this "outreach" function, and this provides one way to undertake it.

5. STS-11 would be held next year in Washington, DC as in the past. We would streamline conference planning in three ways: (1) have the Assemblies prepare and submit to HQ their conference segment from proposals either solicited or submitted in their respective areas; (2) request that presenters submit their registration check with their Proposal Form, with the stipulation that said check would be returned if the proposal could not be accepted; (3) announce that proposals may be submitted at any time, and that those received after the concurrent sessions deadline would be accommodated in poster sessions. These steps would increase participation, reduce costs and lead time, and

simplify procedures, allowing for a desirable second promotional mailing of the fuller submitted program. HQ would continue handling the conference logistics: printing the conference brochure and program, hotel arrangements, fees, etc.

6. We will treat this coming year as a transition period which we put into effect at the March Board Meeting. Certain parts of our present Constitution and Bylaws would require modification, notably Sections 5.3, 5.4 and 9.2 of our Constitution, and Sections 4 and 6 of our Bylaws. Over the coming year we would experiment and work out new Sections to present to the Board and membership for discussion and ratification. Our initial thought is to slim down the Board of Directors to a smaller, self-organizing, and more stable entity: a President elected by Board Members for a three year term, a Vice-President, four Assembly Chairs, the Corporation Chair, and one or more strategically selected individuals local to DC, e.g., Daryl Chubin, (NSF) and Wil Lepkowski (C&EN). To increase the stability of the Board, we propose allowing renewable terms. The President would be one who meets three criteria: a senior person, one known to the community, with available Institutional backup (secretary, xerox, telephone, etc.). To achieve this paring down, we would not hold elections this year, and invite remaining board members at the Board Meeting to affiliate with one of the Assemblies. During this transition year, we would rely on Jane Konrad to complete her anticipated term of President for her normal one-year term.

7. PUBLICATIONS. At zero cost to NASTS, the *Bulletin of Science, Technology and Society* lists us on the cover, archivally prints our program, and gives the STS community a professional platform. It will soon add a peer-reviewed section for the academics. Members would continue getting the *Bulletin* at a major discount. It could now subsume our newsletter, STS Today, by incorporating a page of news about NASTS and adding a short feature section "Assembly News & Viewpoints" of camera-ready material sent by Assembly Chairs. Of course, each assembly could publish any other newsletter it wishes. The teacher community already has a splendid one in Teachers Clearinghouse, and they have expressed interest in printing a similar "NASTS News" page. The current newsletter editor would be responsible for editing these "NASTS News" pages for the various outlets.

NOTES:

STS 10 - CONFERENCE PLANNER

Special Notes		What, Who & Where
	FRIDAY: March 3, 1995	
	7:00 - 8:00 AM	Breakfast
	8:15 - 8:30 AM	Welcome (Mention Alice Moses)
	8:30 - 9:45 AM	PLENARY 1 (Linder-Scholer)
	9:50 - 10:30 AM	Community Breakout
	10:40 - 11:40 AM	Session 1
	11:50 AM - 12:50 PM	Lunch (Meetings)
	1:00 - 2:00 PM	Session 2
	2:10 - 3:10 PM	Session 3
	3:20 - 4:20 PM	Session 4
	4:30 - 5:30 PM	Plenary 2 (Paula Brownlee)
	6:30 - 8:30 PM	Board Meeting
	8:30 - 10:00	Dessert Reception
	SATURDAY: March 4, 1995	
	7:00 - 8:00 AM	Breakfast
	8:00 - 9:00 AM	Session 5
	10:10 - 10:10 AM	Plenary 3 (NACRE)
	10:20 - 11:20 AM	Session 6
	11:30 AM - 12:30 PM	Session 7
	12:30 - 1:30 PM	Lunch
	1:40 - 2:40 PM	Session 8
	2:50 - 3:50 PM	Session 9
	4:00 - 5:00 PM	Session 10
	5:10 - 6:10 PM	Session 11
	6:30 - 7:30 PM	Celebratory Dinner (Present Honorary Membership Awards)
	7:30 - 8:30 PM	Present at the Creation
	8:30 - 9:30 PM	Plenary 4(Lovins)
	9:40 - 10:40 PM	Members Business Meeting
	SUNDAY: March 5, 1995	
	9:50 - 10:50 AM	Session 12
	11:00 AM - 12:00 PM	Plenary 5(Rouse)
	12:00 - 12:20 PM	Change of Guard
	12:30 - 3:30 PM	STS-11 Planning Meeting
	2:30 - 6:30 PM	International STS Planning Meeting

TLC-10 CONFERENCE EVALUATION FORM

Please complete and return to registration table (boxes labeled "STS-10 Evaluations") or mail before April 1, 1995 to NASTS, 133 Willard Bldg., University Park, PA, 16802.

1. With which one assembly or grouping do you most closely affiliate?

    ____ Education, Cutting Across K-12, College, University, and Informal Education
    ____ History, Sociology & Philosophy of Science
    ____ Applied Science, Technology and Engineering
    ____ Public Policy
    ____ Ethics, Values & Religion
    ____ International STS
    ____ Other: ________________________

2. How did you hear about the conference?

3. Why did you come?

4. What did you like best about the conference?

5. What one aspect would you most like to see improved next year?

6. What topics would you most like to have covered next year?

7. Who would you like to hear address the conference next year?

8. Is there some way you would like to participate next year? (Include your name & phone number, or contact us.)

9. What additional comments or suggestions do you have?